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A STUDY OF GALVANOMETRIC DEFLECTIONS DUE TO PSYCHO-PHYSIOLOGICAL PROCESSES. II.

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The following are some of the results obtained:

TABLE I.

EXPERIMENTS ON DR. B.

Galvanometer Readings.[1]	Stimulus.
22.10	
22.10	
10	
10	
⋮	← Sudden question:
22.10	When did your
20	father die?
30	(Intense emotion.)
40	
50	
60	
60	
60	
22.55	
50	
45	
40	
30	
20	
22.00	
22.00	
22.00	
22.00	

Galvanometer Readings.	Stimulus.
20.20	
20.20	
20.20	
20.20	← Difficult calculation.
20.20	
20.20	
20.20	
20.20	
20.20	
20.20	← Slight start by sudden sound.
20.30	
40	
45	
45	
40	
30	
30	
30	
30	
20.30	
22.30	
30	
30	
⋮	← Laughter,

No change.

[1] All readings in this and subsequent tables are in centimeters. Horizontal lines indicate the end of the experiment.

Galvanometer Readings.	Stimulus.
22.40	
50	
22.60	
70	
80	
70	
60	
50	
40	
22.35	
22.30	
22.30	
24.80	
80	
80	
80	
⋮	← Pinch.
90	
95	
25.00	
25.10	
10	
05	
25.00	
95	
90	
85	
80	
80	
24.80	
⋮	
No change: 15.35	
35	
⋮	← Looked at pictures.
35	
35	
35	
35	
35	
24.75	
75	
75	
75	
⋮	← Pinch.

Galvanometer Readings.	Stimulus.
24.80	
85	
90	
95	
25.00	
00	
24.95	
90	
85	
80	
75	
70	
70	
24.70	
⋮	
15.40	
40	
40	
⋮	← Pin prick.
45	
50	
55	
60	
65	
70	
75	
80	
80	
70	
65	
60	
55	
50	
45	
15.45	
No change: 22.30	
22.30	
⋮	← Thinking of being pricked.
22.30	
No change: 21.45	
21.45	
45	
⋮	← Thinking of father's recent death.
21.45	

Galvanometer Readings.	Stimulus.
No change. 21.45	
45	
45	← Recalling dream of seeing dead father.
⋮	
21.45	
21.45	
45	
⋮	← Imagines pleasant experience.
21.45	
21.45	
45	
⋮	← Slight laughter.
50	
60	
70	
80	
90	
22.00	

Galvanometer Readings.	Stimulus.
22.00	
⋮	← Burn with lighted cigarette. (Very painful.)
10	
20	
30	
40	
50	
60	
70	
80	
90	
80	
70	
60	
50	
22.40	
⋮	
Galv. dropping.	
Exp. discontinued.	

TABLE II.

EXPERIMENTS ON DR. ST.

Galvanometer Readings.	Stimulus.
17.40	
17.40	
40	
⋮	← Burn.
45	
50	
55	
60	
65	
65	
60	
55	
50	
50	
⋮	
18.00	
00	
00	
⋮	← Dropping weight.
05	
10	
18.15	

Galvanometer Readings.	Stimulus.
18.20	
30	
35	
35	
30	
25	
20	
15	
10	
05	
05	
05	
05	
05	
18.05	
18.30	
30	
30	
⋮	← Pinch.
35	
40	
18.45	

Galvanometer Readings.	Stimulus.
18.50	
55	
50	
45	
40	
35	
35	
35	
35	
35	
⋮	
No change. 20.30	
30	
⋮	← Thinks of disagreeable experience.
30	
30	
30	
20.30	← Slight artificial laughter.
30	
40	
50	
60	
70	
80	
90	
80	
70	
60	
50	
⋮	
No change. 22.60	
60	
60	
⋮	← Multiply 17 × 15.
60	
60	
55	
55	
60	
60	
60	
60	
22.60	

Galvanometer Readings.	Stimulus.
No change. 22.60	
60	
60	
⋮	← Divide $\frac{17}{11}\frac{11}{11}$.
60	
60	
60	
60	
60	
60	
⋮	
22.60	
60	
60	
⋮	← Presented mirror to face unexpectedly
65	
70	
75	
80	
85	
90	
95	
23.00	
00	
22.95	
90	
85	
80	
75	
70	
65	
60	
⋮	
22.60	
60	
23.00	
00	
00	
⋮	← Pinch.
05	
10	
15	
20	
23.25	

Galvanometer Readings.	Stimulus.
23.30	
35	
40	
40	
35	
30	
25	
20	
15	
10	
05	
23.00	
22.90	
90	
90	
⋮	← Electric shock.
22.95	
95	
23.00	
05	
10	
15	
15	
10	
05	
23.00	
22.95	
90	
90	
⋮	
22.80	
22.80	

Galvanometer Readings.	Stimulus.
22.80	
80	
80	
⋮	← Coughed.
85	
90	
95	
23.00	
05	
10	
15	
20	
25	
30	
30	
25	
20	
15	
10	
05	
23.00	
22.90	
80	
22.80	
⋮	
No change. 22.80	
80	
⋮	← Capital of Portugal?
22.80	
⋮	← Capital of Ireland?
22.80	

TABLE III.

EXPERIMENTS ON DR. S.

Galvanometer Readings.	Stimulus.
24.00	
00	
⋮	← Pinch.
05	
10	
15	
20	
25	
24.30	

Galvanometer Readings.	Stimulus
24.35	
40	
40	
35	
30	
25	
20	
15	
24.10	

Galvanometer Readings.	Stimulus.
24.05	
24.00	
⋮	
13.60	
60	
60	
⋮	← Dropping weight.
65	
70	
75	
80	
85	
90	
90	
85	
80	
75	
70	
65	
13.65	
⋮	
23.90	
90	
90	
⋮	← Burn.
95	
24.00	
05	
24.10	
15	
20	
25	
30	
35	
40	
40	
35	
30	
25	
20	
10	
23.90	
17.20	
17.20	

Galvanometer Readings.	Stimulus.
17.20	
⋮	← Artificial laughter.
30	
40	
50	
60	
70	
80	
90	
18.00	
⋮	
23.50	
60	
70	
80	
90	
24.00	
00	
00	
00	
24.00	
24.00	
⋮	
13.70	
70	
70	
⋮	← Smelled CS_2.
80	
85	
90	
95	
14.00	
00	
13.95	
90	
85	
80	
75	
13.75	
⋮	
No change. 15.35	
35	
⋮	← Thinking of something disagreeable.
35	
35	

	Galvanometer Readings.	Stimulus.
No change.	15.35	
	35	
	⋮	← Solving difficult problem.
	35	
	35	

	Galvanometer Readings.	Stimulus.
No change.	15.35	
	35	
	⋮	← Shown pictures.
	35	
	35	

TABLE IV.

EXPERIMENT ON DR. C.

Galvanometer Readings.	Stimulus.
24.75	
75	
75	
⋮	← Burn.
80	
85	
90	
95	
25.00	
00	
24.95	
90	
85	
80	
75	
70	
24.70	
⋮	

Galvanometer Readings.	Stimulus.
24.55	
55	
55	
⋮	← Pinch.
60	
65	
70	
80	
90	
90	
80	
70	
24.60	

Galvanometer Readings.	Stimulus.
24.55	
50	
50	
24.50	
⋮	

23.25	
25	
25	
⋮	← Sudden noise.
30	
40	
50	
60	
70	
80	
90	
24.00	
00	
23.95	
90	
23.85	
⋮	

(Experiment stopped.)

23.30	
30	
⋮	← Solving difficult problems mentally.
30	
23.30	
⋮	

TABLE V.

EXPERIMENTS ON MR. R.

Galvanometer Readings.	Stimulus.
18.20	
20	
20	
⋮	← Drop weight.
25	
30	
35	
40	
45	
50	
50	
45	
40	
35	
30	
25	
18.25	
⋮	
23.15	
15	
15	
⋮	← Slight noise.
20	
25	
23.30	

Galvanometer Readings.	Stimulus.
23.35	
30	
25	
20	
15	
10	
10	
23.10	
⋮	
12.00	
00	
⋮	← Sudden loud shout.
10	
20	
30	
40	
50	
60	
50	
40	
30	
20	
10	
12.00	
⋮	

Plotting galvanometric deflections as ordinates and time as abscissæ a series of curves is obtained.

Out of a large number we have selected a few typical ones which show clearly the relative variations of galvanometric deflections under various conditions of stimulation. Where requisite we indicate in a short note the essential characteristic of each particular curve.

An examination of the tables and curves shows that pure ideational processes such as thinking, calculation, solving problems, representing pleasant or painful experiences and even æsthetic experiences such as looking at pictures have *no* effect, while *sudden violent emotions* and especially *intense sensory stimulations* of a painful or of a very disagreeable

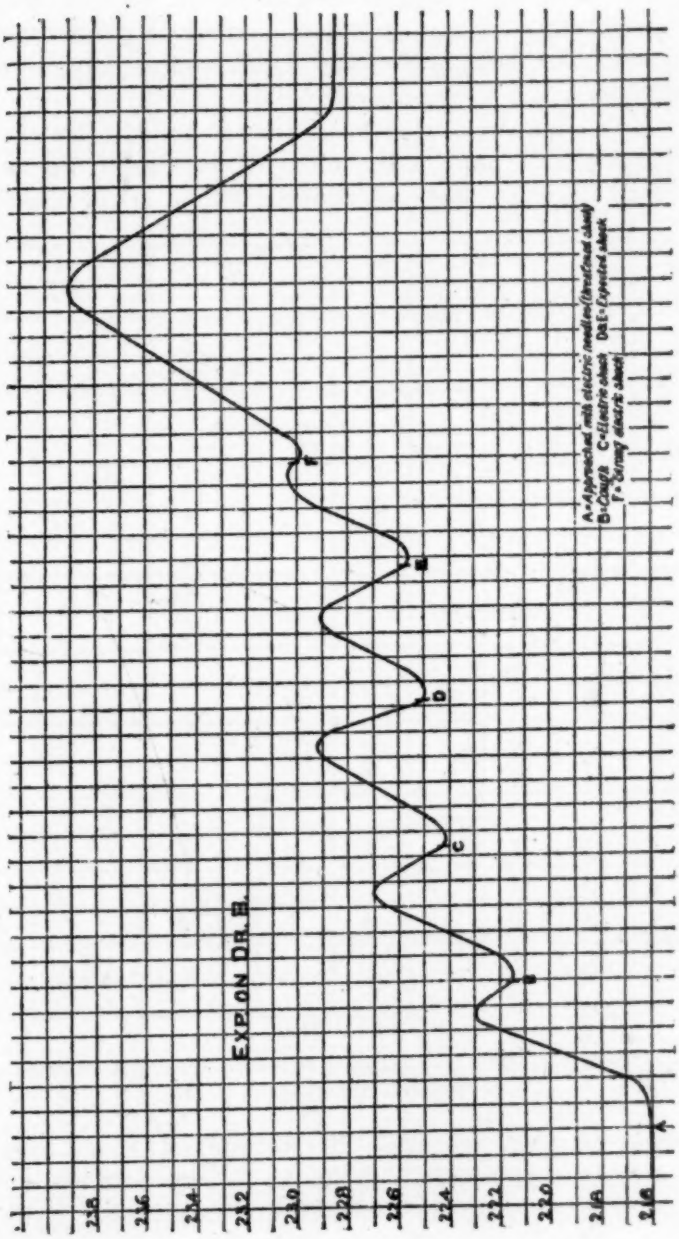


FIG. 2.—DR. B. sensitive to electricity. Shows the influence under strained expectation of electric shock.

character, such as burns, pricks, pinches, electric shocks and unpleasant smells are followed by marked galvanometric deflections. The deflections diminish and finally disappear with the repetition of the *same* sensory stimulation.

It will be observed that there is a latent period between the time of stimulation and the beginning of the rise of the curve. This latent time is somewhat variable, but is of the order of

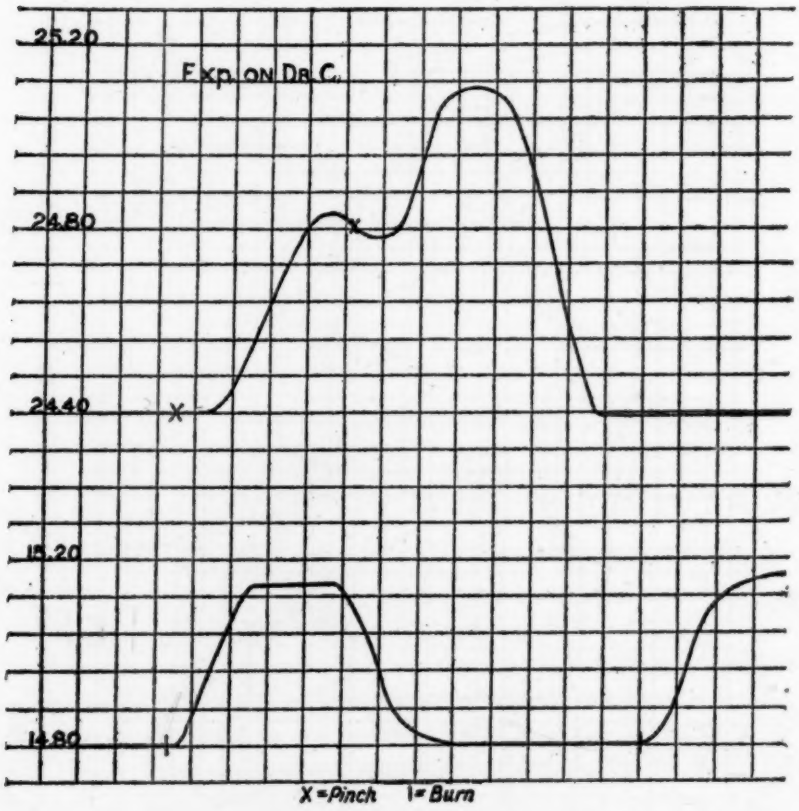


FIG. 3.—The curves show deviations due to *simple* sensory stimulation and superimposed sensory stimulation.

magnitude of a few seconds. No attempt was made to study accurately such latent periods; the curves represent the magnitude of the deflection in terms of arbitrary time units. Particular attention will be paid to this point in a subsequent study.

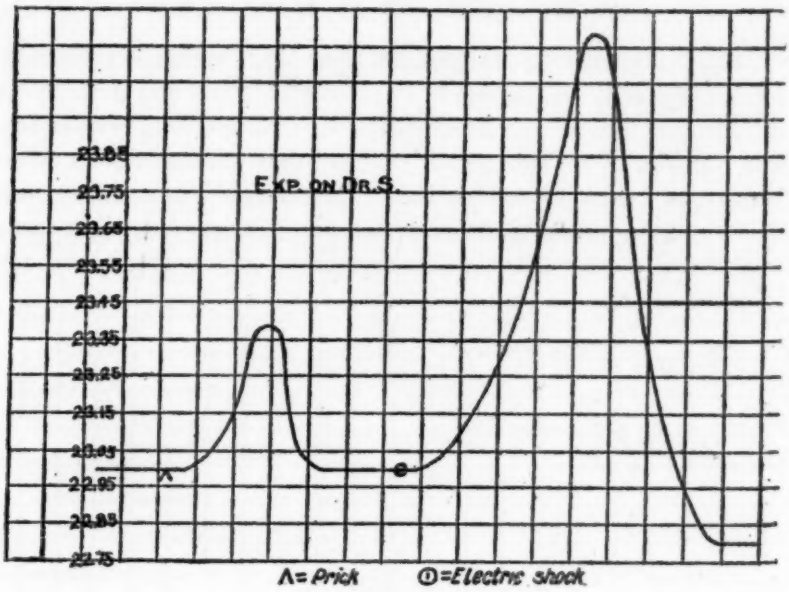


FIG. 4.

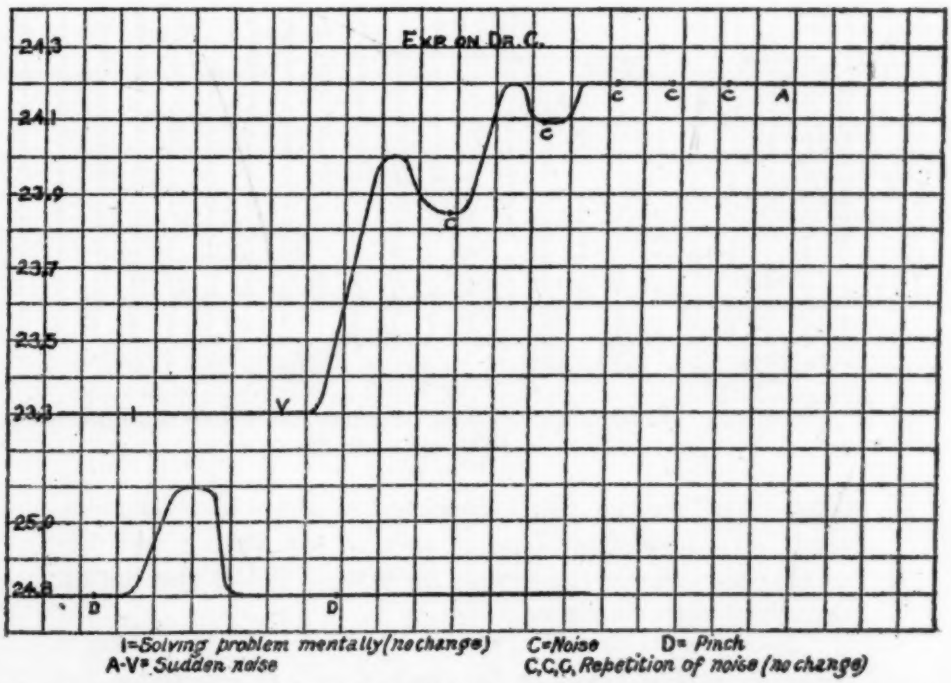


FIG. 5.—The galvanometric deviations *diminish* and finally *disappear* with superimposed stimulations of same kind.

It need hardly be pointed out that such definite variations cannot possibly be ascribed to changes in the circuit such as the introduction of thermo-electromotive forces, magnetic effects and the like; for these could scarcely time themselves to occur just at the instant of stimulation. For the sake of completeness of demonstration, however, a resistance box was introduced into the circuit across the electrodes *EE* in place of the human

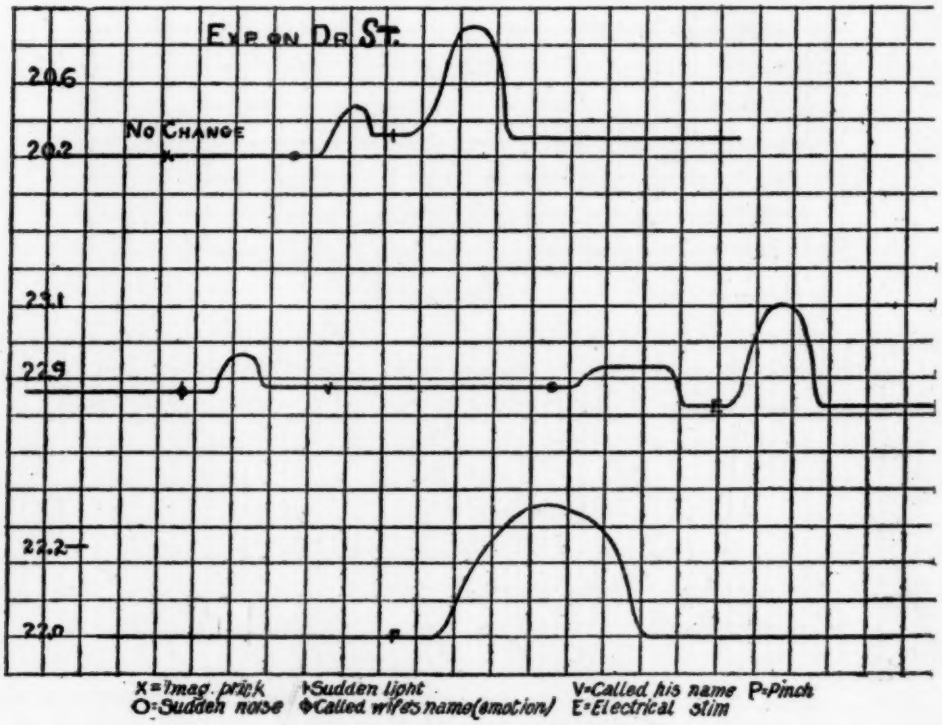


FIG. 6.—This curve brings out well the relative deviations due to pure representation, as compared with *emotional* and sensory processes.

body. The reading remained steady to within one half millimeter for an indefinite time in spite of the jarring and disturbances which were purposely made more violent than during the experiments on the subjects.

Hence we conclude that the observed galvanometric changes do not take their origin in the physical part of the circuit, but

are caused by physiological processes concomitant with the mental states aroused by the stimuli.

We next pass to the study of the nature of these physiological processes.

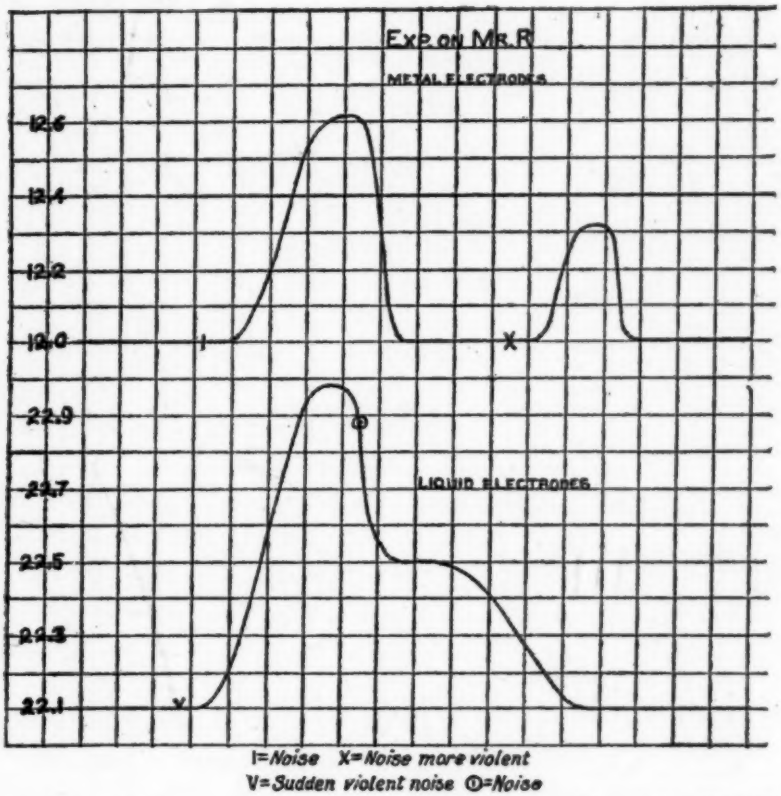


FIG. 7.—These two curves of galvanometric deviations with metal and liquid electrodes under the same conditions of sensory stimulations may be regarded as typical.

PART II.

I.

The galvanometric variations during emotional states may be taken to indicate that the physiological processes accompanying emotions change the resistance of the circuit by changing the resistance of the body. This resistance factor is the one to

which these variations are commonly referred by previous investigators. Further experimentation, however, points in a different direction.

It seemed highly probable that not an inconsiderable fraction of the total resistance of the body measured by the immersion of the hands in our liquid electrodes was due to the skin layer. Variations in the skin area in contact with the electrodes were

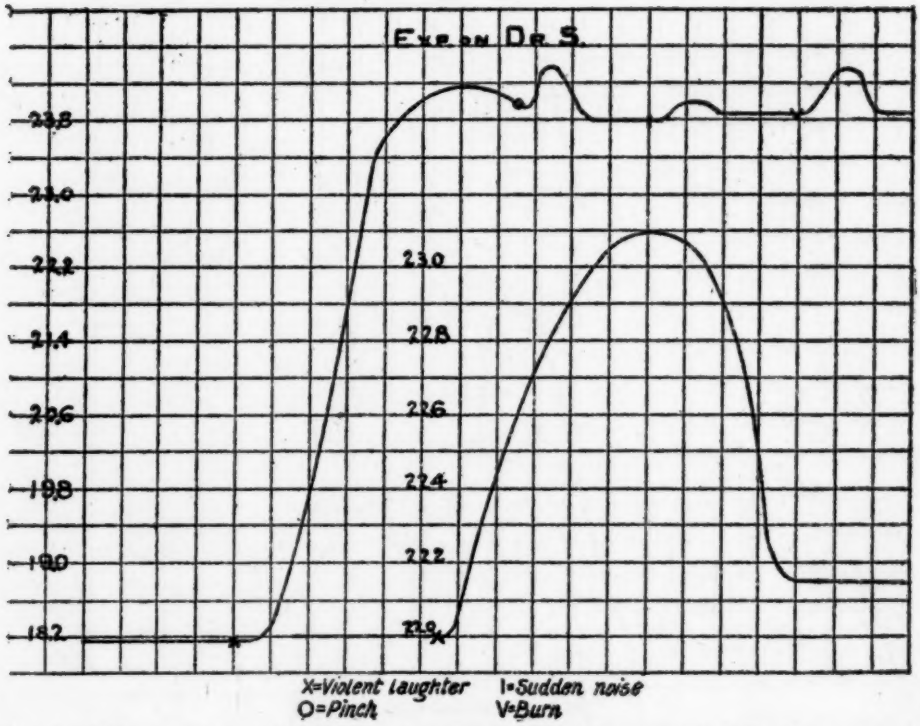


FIG. 8.—This curve is especially instructive, showing the galvanometric deflection produced by laughter as compared with variations caused by sensory stimulations.

eliminated by the use of liquid electrodes instead of metal electrodes used by other investigators. The shellac and paraffin with which we covered the subject's wrists as well as the splints put on the hands made the skin area washed by the liquid electrodes constant, so much so that violent stirring of the liquid with the hands did not change the reading of the galvanometer. The galvanometric variations observed under conditions of stimu-

lation could not therefore be referred to variations in skin contact.

If resistance be the factor, then the galvanometric variations observed may either be due to changes of resistance of the con-

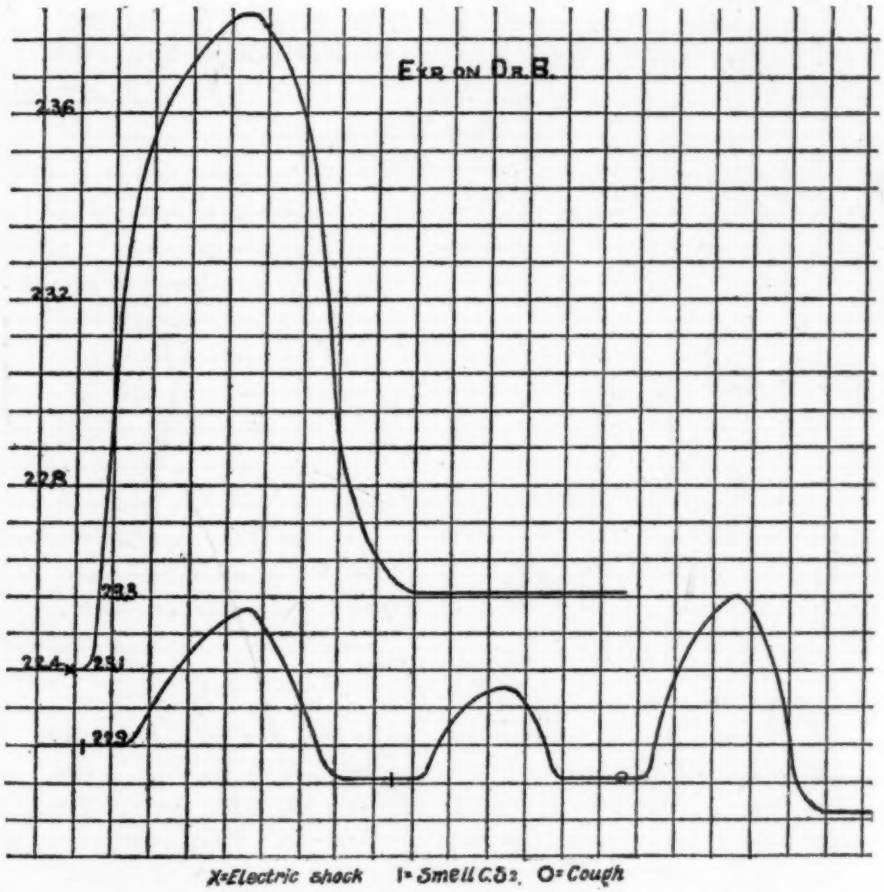


FIG. 9.—Dr. B. throughout the experiments gives a large deflection to electric stimulations even to expected ones as he is quite sensitive to electricity.

stant area of the skin or of the body through which the current passes. That the galvanometric deflections are due to variations in resistance of the skin is a view commonly held by many investigators.

Skin resistance can, however, be eliminated by the following procedure: Hypodermic needles were inserted well under the skin until blood flowed freely. The hands with the needles in position were placed within the liquid electrodes. The change in deflection was slight, about 2 millimeters in a total deflection of 20 centimeters, or about 1 per cent. After a few minutes the reading was the same as before the insertion of the needle

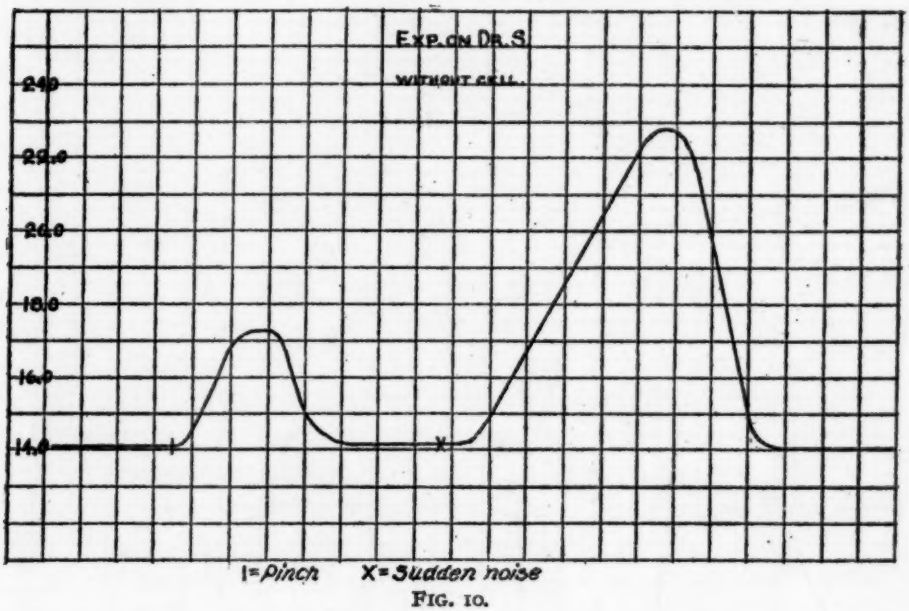


FIG. 10.

electrodes. The deflection was probably due to the stimulation caused by inserting the needles. That is, after a few minutes the deflections with the needle electrodes did not differ from those without the needle electrodes. Skin resistance was even more conclusively eliminated by a series of experiments which will be described in their appropriate place. With the needles inserted curves identical in form with the preceding ones were obtained. Following are two curves typical of a number obtained under these conditions.

In considering the resistance of the body we may possibly regard the temperature of the body as a factor concerned in the observed galvanometric deflections. Electrolytes have a posi-

tive temperature coefficient of about 2 per cent. per degree. It was thought that contractions of the muscles, voluntary and involuntary, as well as other catabolic processes that may go on in the body during an emotional state may possibly develop heat and thus account for the change in the deflections. Granted that sufficient heat is developed by muscular and chemical activities involved in the catabolic physiological processes

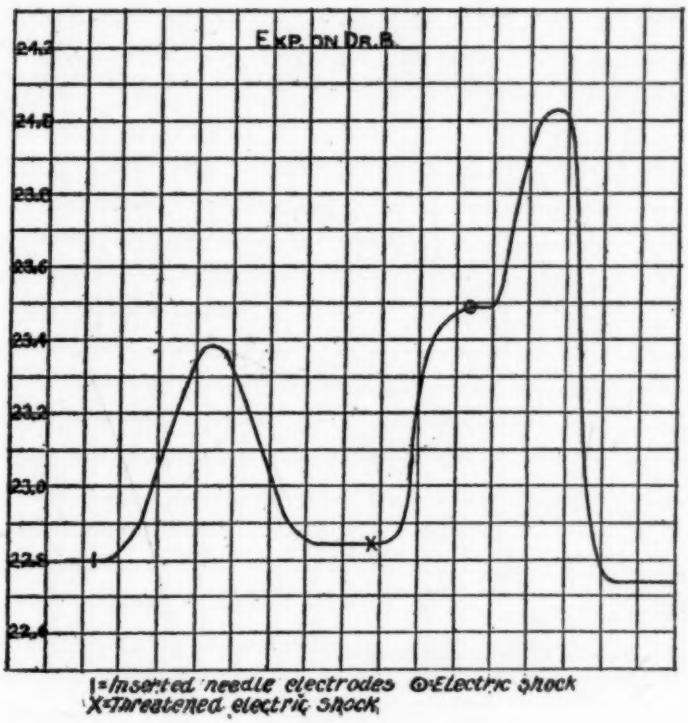


FIG. 11.

concomitant with emotional states we may well account for the galvanometric variations. The factor of temperature had all the more to be taken into consideration as the experiments performed seemed to point in that direction. That is, bending of the arm, strenuous bending of the head, rising, sitting, coughing, laughing, whether spontaneous or artificial, any violent muscular strain or exercise especially of the arms gave rise to

appreciable variations. Thus in some cases violent laughter, though artificial in character, caused a galvanometric deflection of 6–8 centimeters. Under other more favorable conditions described further the deflection amounted to more than 50 centimeters.

We may also call attention to the experiments in which we artificially varied the temperature of the arms. Heating and cooling the arms put in an Esmarch bandage so as to exclude circulatory variations brought about galvanometric deflections.

The experiments with hot and cold applications gave but slight variations insufficient to account for the galvanometric

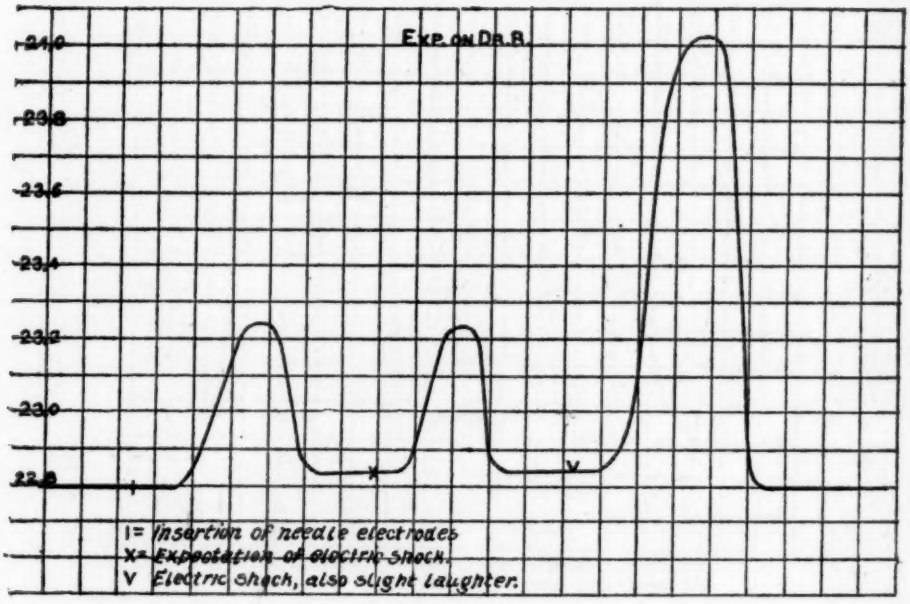


FIG. 12.

phenomena observed under the influence of emotional states. The variations due to raising the temperature did not differ from those due to lowering the temperature. Furthermore, after a minute or two of continuous cooling or heating the arms the reading was the same as that before the temperature change. The hot and cold applications acted therefore in the nature of mere temperature stimulations.

The galvanometric variations observed upon rising and sitting were just as marked when the subject was raised passively and lowered passively as when he raised himself actively so that there was no question of exercise. Rising and sitting, changes in the position of the arms, was responsible for variations. The curves, Figs. 13–19, show the effect clearly.

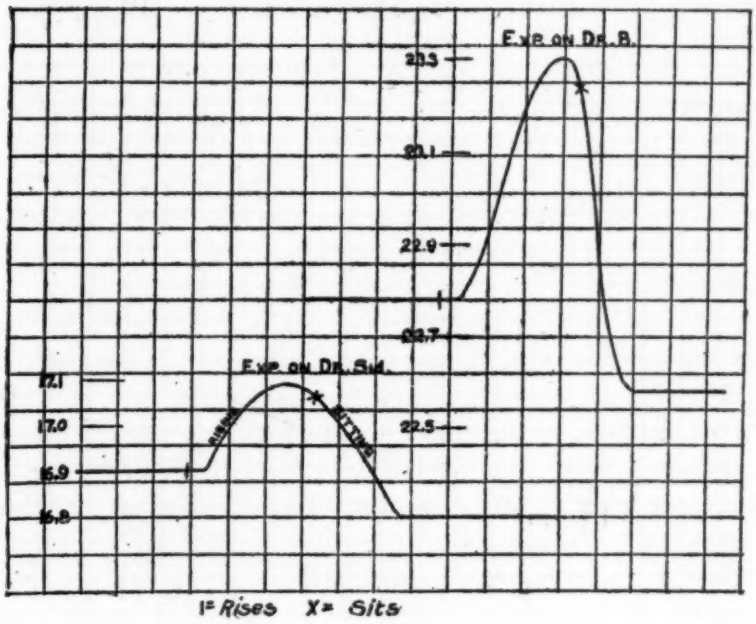


FIG. 13.

From these experiments it seems that muscular activity of those parts of the body actually forming the circuit bring about galvanometric deflections, while activity of the more remote parts of the body are ineffective.

II.

It was supposed that the galvanometric deflections might be due to variations of the circulation under the influence of emotions. The circulation was cut off by Esmarch bandages. A galvanometric deflection was observed on putting on the Es-

march bandages and also on taking them off, as it was in the case of any other intense stimulus. What, however, completely eliminates circulation as the determining factor is the significant fact that when the Esmarch bandages were on, galvanometric deflections were obtained under conditions of sensory stimulation and arousal of emotional states. The Esmarch bandages were kept on the subject as long as he could stand

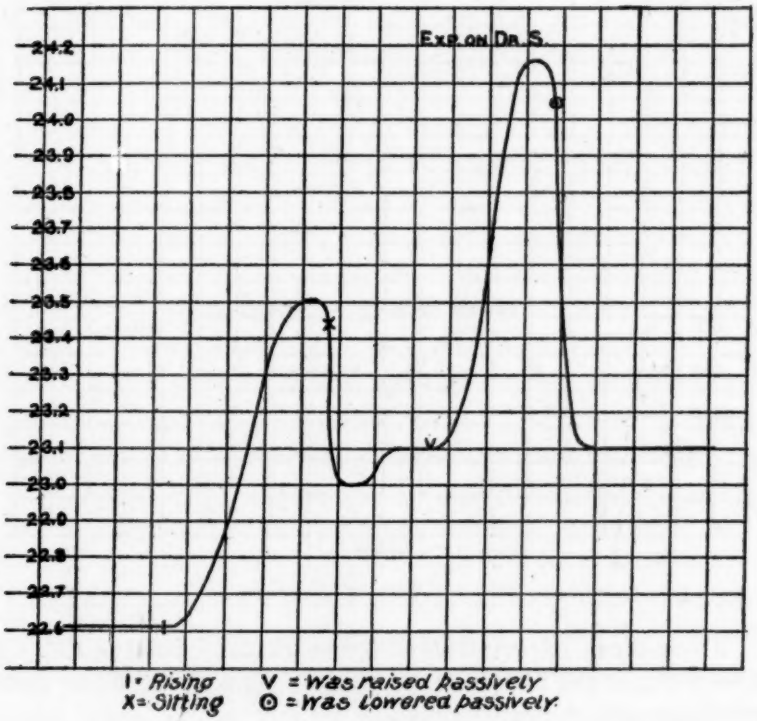


FIG. 14.

them. The circulation was effectually cut off, the pulse was gone and the hand assumed a cadaverous hue; still the same galvanometric deflections were easily obtained under the same mental and purely physiological conditions, such as emotions, sudden sensory stimulations, rising, sitting, coughing, laughing and muscular activity, especially of the arms.

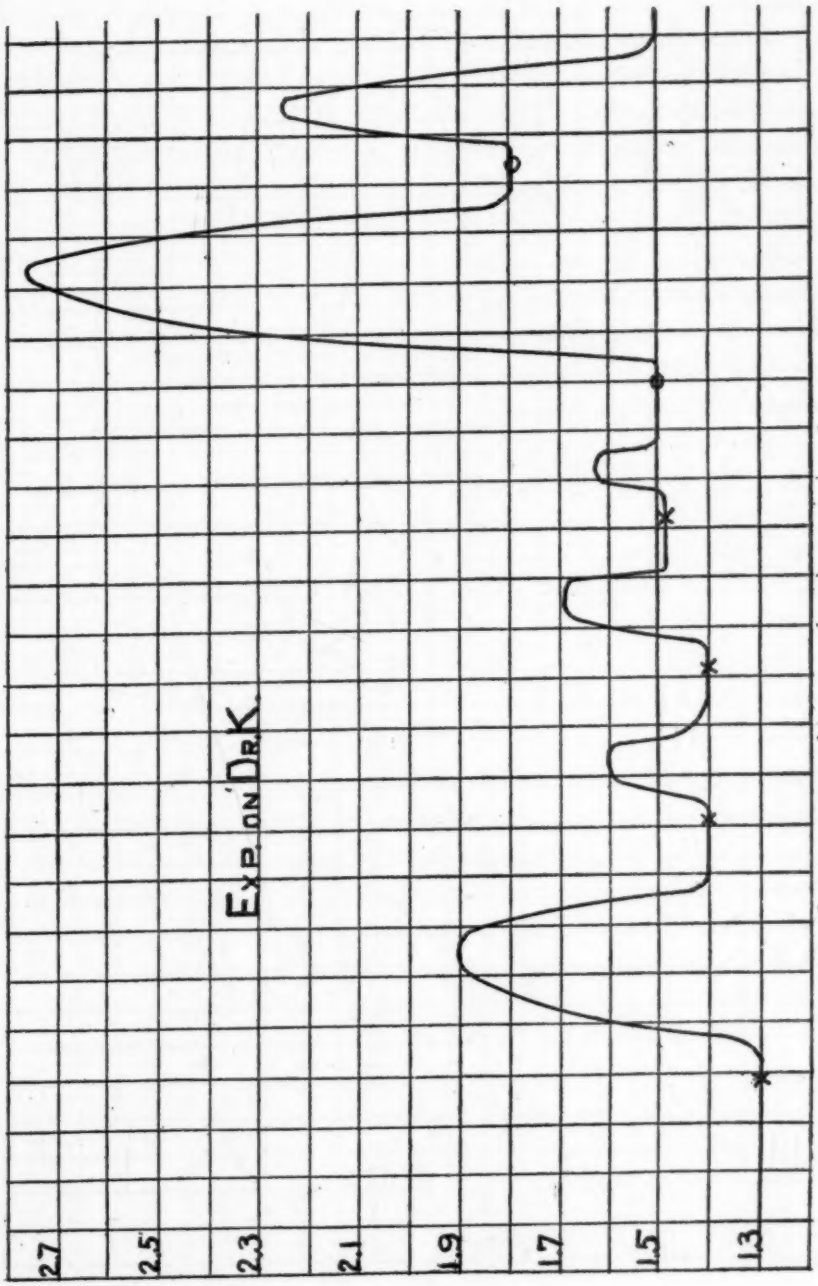

Exp. on Dr. K.
2.7
2.5
2.3
2.1
1.9
1.7
1.5
1.3
X = Pinch (arms stiff.) O = Sudden noise (arms stiff)

FIG. 15.

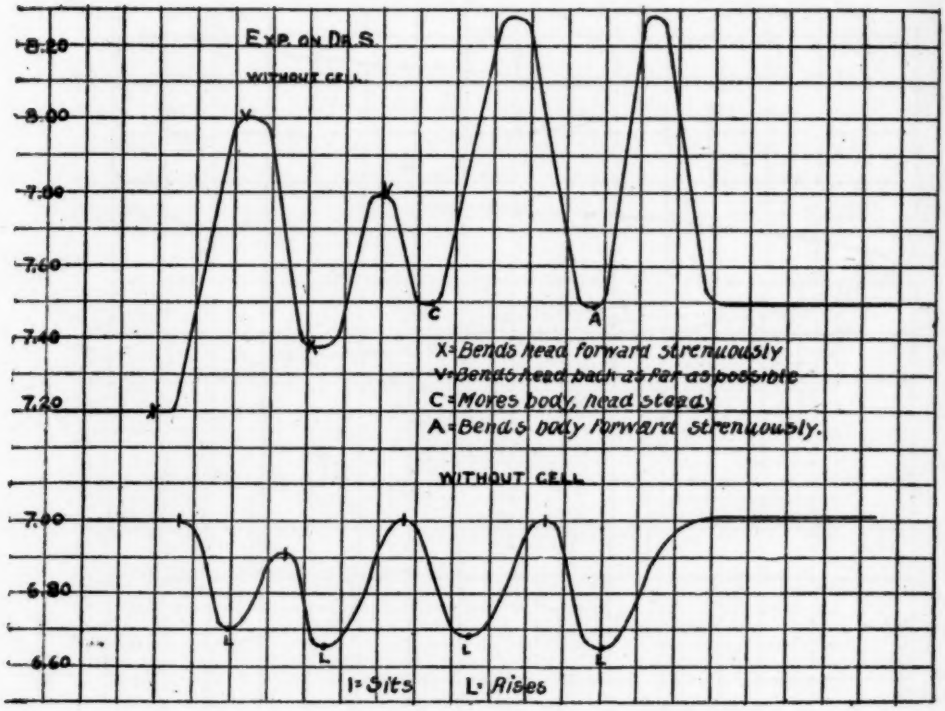

EXP. ON DR. S.
WITHOUT CELL.
8.20
8.00
7.80
7.60
7.40
7.20
X=Bends head forward strenuously
V=Bends head back as far as possible
C=Moves body, head steady
A=Bends body forward strenuously.
WITHOUT CELL.
7.00
6.80
6.60
I=Sits
L=Rises

FIG. 16.

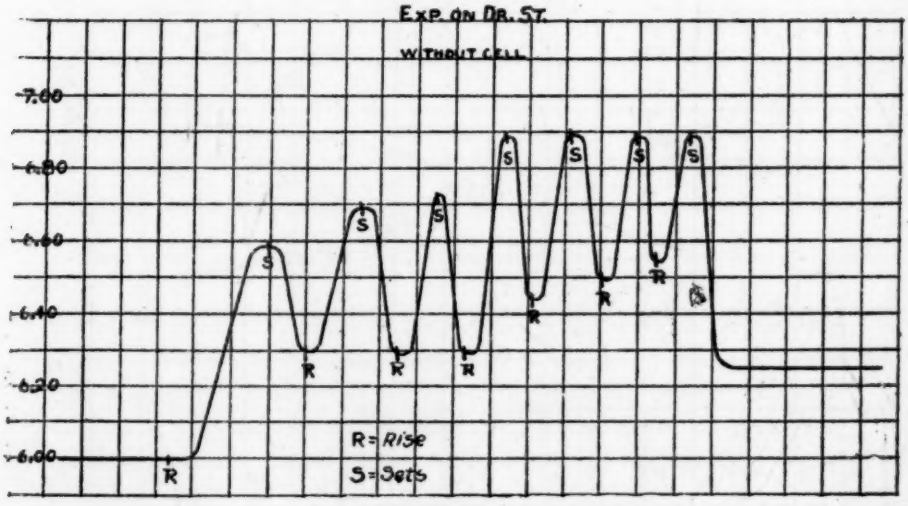

EXP. ON DR. ST.
WITHOUT CELL.
7.00
6.80
6.60
6.40
6.20
6.00
R=Rise
S=Sets

FIG. 17.

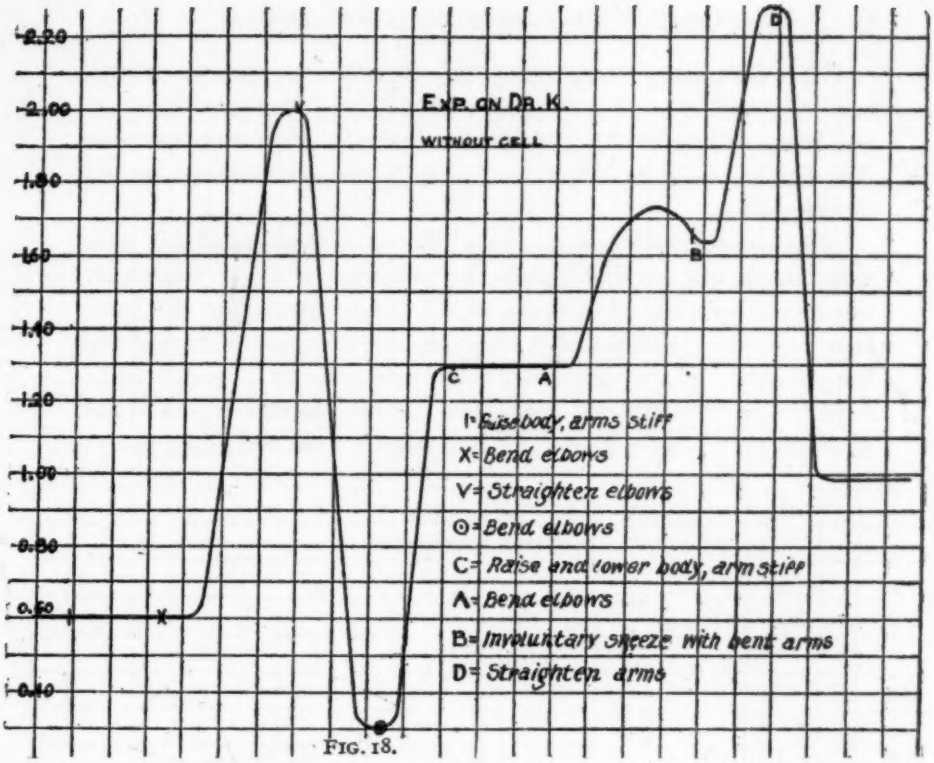
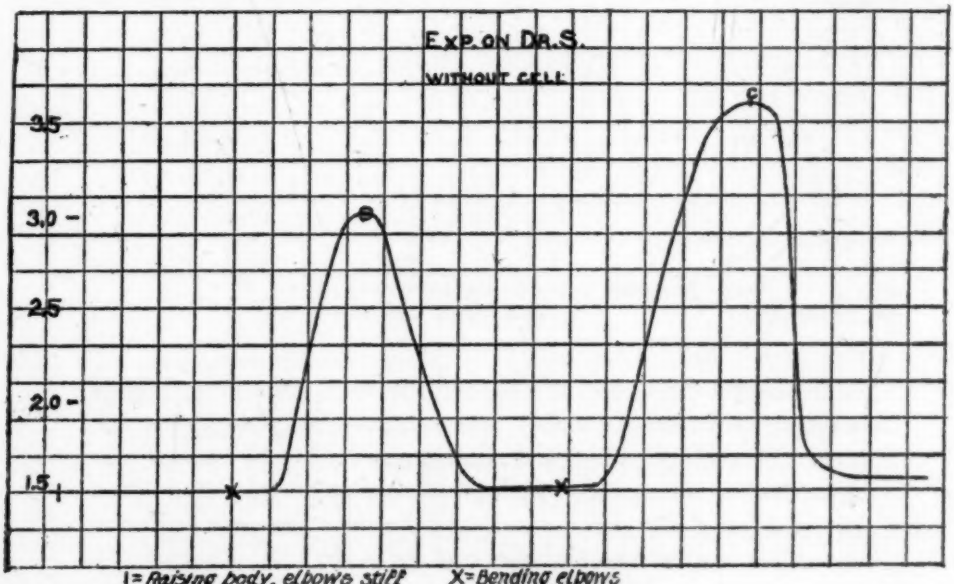


FIG. 18.



I= Raising body, elbows stiff
O= Stiffening arms.
X= Bending elbows
C= Stiffening elbows.

FIG. 19.

The following curves may be regarded as typical of the rest:

These experiments prove conclusively that the circulation has nothing to do with the galvanic phenomena under investigation.

Our experiments go to prove that the causation of the galvanometric phenomena cannot be referred to skin resistance, nor can it be referred to variations in temperature, nor to circulatory changes with possible changes in the concentration of the body-fluids. Since the electrical resistance of a given body depends on two factors — temperature and concentration — the elimination of both factors in the present case excludes body-

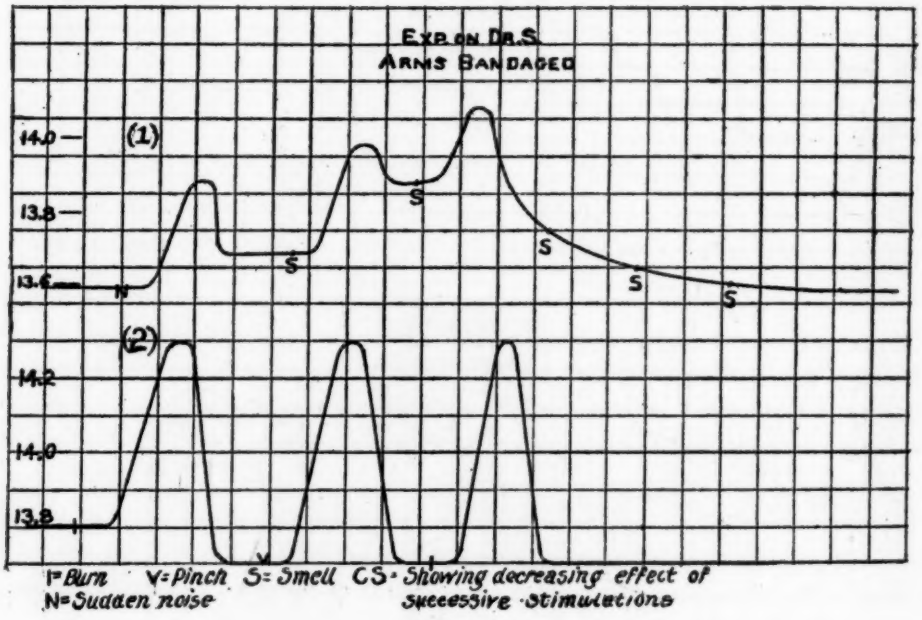


FIG. 20.

resistance as the cause of the deflections. Our experiments therefore prove unmistakably that the galvanic phenomena due to mental and physiological processes cannot be referred to variations in resistance, whether of skin or body. *Resistance being excluded the galvanometric deflections can only be due to variations in electromotive force of the body.*

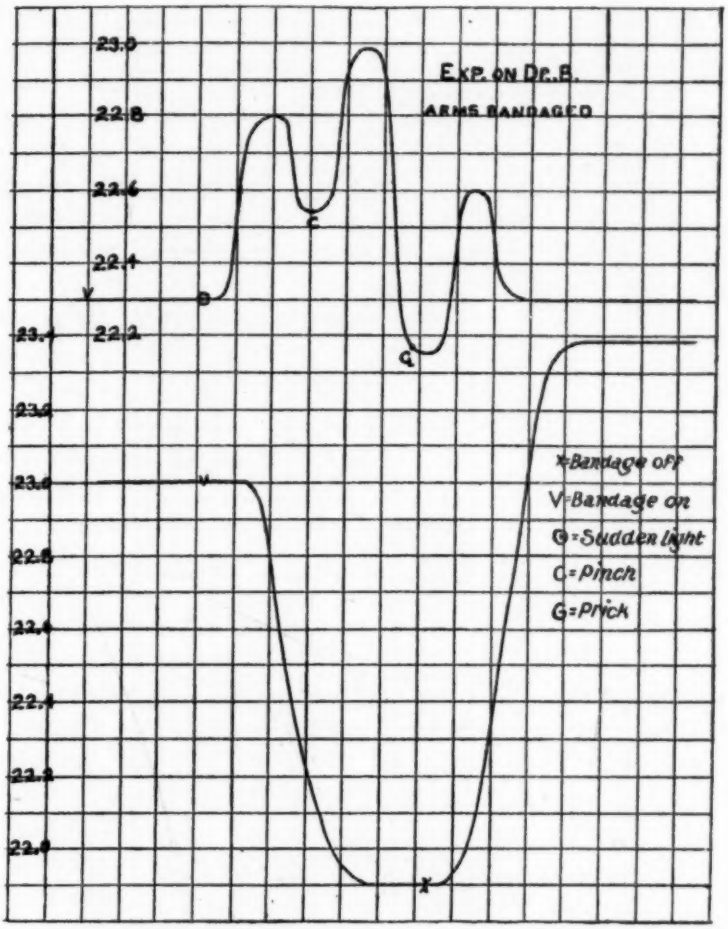


FIG. 21.

III.

In our experiments on the electromotive force we were partly guided by Dr. Waller's work on the electromotive changes connected with the beat of the mammalian heart.[1] The heart-beat should be taken into consideration as one of the possible causes of galvanometric deflections due to various psycho-physiological

[1] *Philosophical Transactions of the Royal Society of London*, Vol. 180, p. 169, 1889.

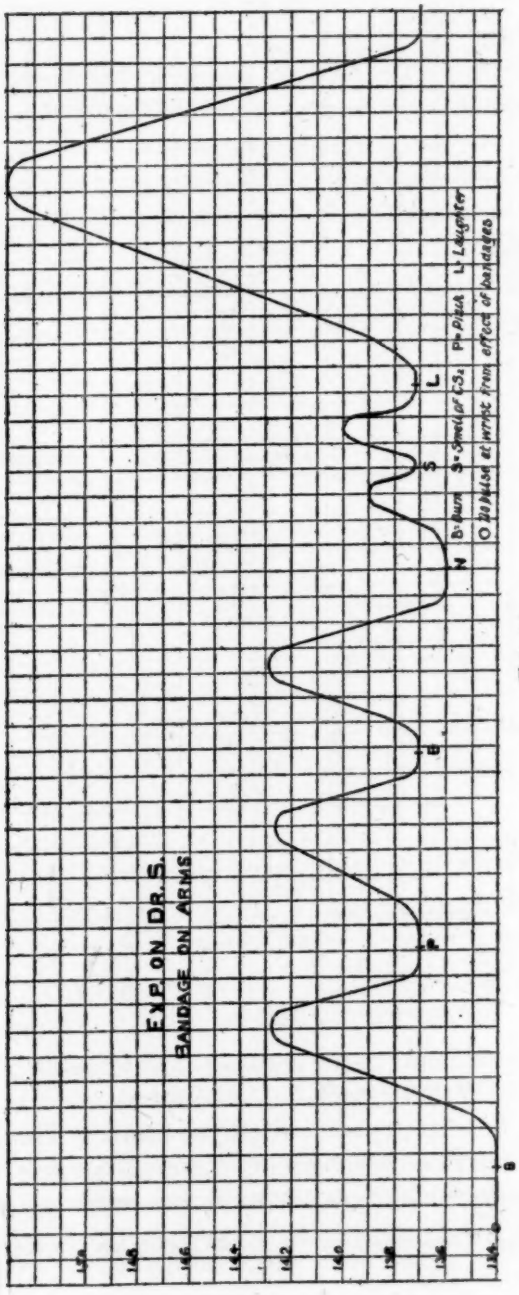

EXPLOR.S.
BANDAGE ON ARMS
B
P
E
N
S
L
B-Rum S-Smell of CS2 Pp-Pain L-Laughter
O-Pulse at wrist from effect of bandages
150
148
146
144
142
140
138
136
134

FIG. 22.

and purely psychological processes. Experimenting with the capillary electrometer Waller came to the conclusion that "a marked electrical variation is manifested at each pulsation of the heart." This electrical variation was manifested by 'leading off' from the surface of the body. Thus with each beat of the heart an electromotive force is set up causing a non-symmetrical distribution of potential over the body. To quote Waller: "The contraction of the ventricles is not simultaneous throughout the mass, but traverses it as a wave. Inequalities of potential at different parts of the mass are consequently established at the beginning and at the end of each systole. Or to reverse the order of statement, the inequalities in question are proof of the passage of a wave of excitation. The distribution of these inequalities of potential is represented diagrammatically in Fig. 24.

"These data being transferred to the entire body as in Fig. 24 we have the portion *a*, *a*, *a* . . . as the area in which the potential of *A* is distributed, and the portion *b*, *b*, *b* . . . as the area in which the potential of *B* is distributed.

"Electrical variations will be manifested when any two points *a* and *b* are led off; no electrical variations will occur when any two points *a* and *a*, or *b* and *b*, on the same equipotential line, are led off; small electrical variations will be obtained when two points *a* and *a*, or *b* and *b* on different equipotential lines are led off."

Working with the capillary electrometer Waller found that certain combinations were favorable, while others were unfavorable to manifestations of marked electrical variations due to cardiac beat. The favorable combinations were the following:

Left hand and right hand.
Right hand and right foot.
Right hand and left foot.
Mouth and left hand.
Mouth and right foot.
Mouth and left foot.

The unfavorable combinations were:

Left hand and left foot.
Left hand and right foot.

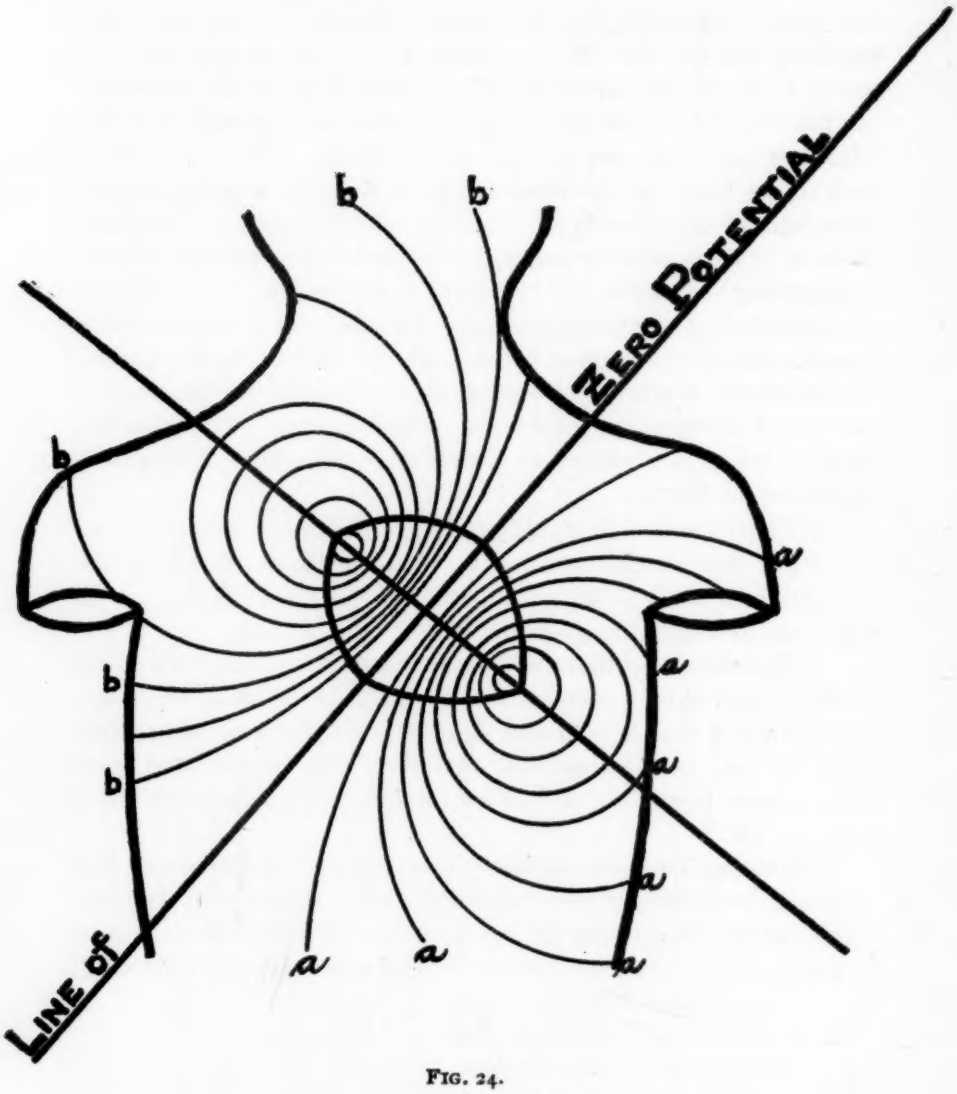


FIG. 24.

Right foot and left foot.

Mouth and right hand.

In short, according to Waller, electrical variations are observed when two dissimilar points are connected with the electrometer, while electrical variations are absent or faint when two

similar points are connected, similar and dissimilar points being defined according to Fig. 24.

We repeated Waller's experiments, but we could not confirm his results. Our experiments do not confirm his favorable or unfavorable combinations. Further work is in progress in this connection. What we did find was that a reversal of position of the hands — putting the right in place of the left hand — made a difference in the magnitude of the deflection and occasionally in its direction.

To define positive and negative deflections for our experiments, a cell was introduced into the circuit and the direction of the deflection was called positive. The terminal of the galvanometer to which the positive pole of the cell was connected was consequently defined as positive. In the following record of data, therefore, l. h. (+) means that the left hand was connected to the positive terminal of the galvanometer thus defined. The following tables give the results of our experiments:

TABLE VI.

EXPERIMENTS ON DR. S.

First Series.

zero reading	+ 25.0
l. h.[1] (+)	+ 8.5
l. h. (−)	+ 18.0
zero reading	+ 25.0
l. h. (+)	+ 9.5
l. h. (−)	+ 18.5
zero reading	+ 25.0
l. h. (+)	+ 9.5
l. h. (−)	+ 18.0
l. h. (+)	off scale +
l. h. (−)	off scale −

Repeated 5 times; same results.

TABLE VII.

EXPERIMENTS ON DR. S.

Second Series.

l. h. (+)	− 8.0
l. h. (−)	+ 5.5
l. h. (+)	− 7.0
l. h. (−)	+ 5.8

[1] l. h. stands for left hand; r. h. stands for right hand.

l. h. (+) ..... − 7.5
l. h. (−) ..... + 5.2
l. h. (+) ..... − 7.2
l. h. (−) ..... + 5.0

Table VIII.

Experiments on Mr. R.

l. h. (+) .....+ 10.0
" .....+ 10.5
" .....+ 11.0
l. h. (−).... ..... 0.0
" 0.0
" 0.0

	Defl. 1	2
mouth (−) r. h. (+).....	7.2	7.5
mouth (+) r. h. (−).....	7.6	6.0
mouth (−) l. h. (+).....	7.2	7.5
mouth (+) l. h. (−).....	6.5	6.0

(2) is a repetition of experiment (1).

Table IX.

Experiments on Dr. B.

zero .....− 25.0
l. h. (+).....+ 3.0
l. h. (−).....− 7.0
zero .....− 25.0
l. h. (−).....+ 3.0
l. h. (−).....− 6.5
zero ....− 25.0
l. h. (+).....+ 3.0
l. h. (−).....− 6.5
l. h. (+).....+ 14
l. h. (−).....− 13

mouth (+) r. h. (−) ..... + 25.0
mouth (−) l. h. (+) ..... + 25.0
mouth (−) r. h. (+) ..... + 25.0
mouth (+) l. h. (−) ..... + 25.0

Table X.

Experiments on Dr. K.

l. h. (+)..... .....− 12.5
l. h. (−).....+ 11.0
l. h. (+).....− 13.0
l. h. (−).....+ 11.4
l. h. (+).....− 12.0
l. h. (−).....+ 11.5

TABLE XI.

EXPERIMENTS ON MR. COL.

First Series.

1. h. (+)	+ 6.0
1. h. (—)	+ 11.0
1. h. (+)	+ 5.0
1. h. (—)	+ 10.0
1. h. (+)	+ 4.5
1. h. (—)	+ 10.0
1. h. (+)	+ 4.5
1. h. (—)	+ 9.0

TABLE XII.

EXPERIMENTS ON MR. COL.

Second Series.

1. h. (+)	— 4.5
1. h. (—)	— 7.0
1. h. (+)	— 3.0
1. h. (—)	— 7.0
1. h. (+)	— 3.0
1. h. (—)	— 7.2
1. h. (+)	— 2.8
1. h. (—)	— 7.3

TABLE XIII.

EXPERIMENTS ON DR. ST.

1. h. (+)	+ 2.7
1. h. (—)	+ 1.4
1. h. (+)	+ 2.6
1. h. (—)	+ 1.2
1. h. (+)	+ 2.2
1. h. (—)	+ 0.9

From these tables it is clear that the absolute magnitude of the deflection varies according to the varying conditions of the experiment. Different experiments performed with different concentration of electrode solutions gave different deflections, in fact the direction and magnitude was varied at will in this way. Also substituting lead electrodes for copper electrodes changed the deflections largely, *and different parts of the skin gave different original deflections.* However, superimposed upon this original steady deflection is a deflection due to the various stimulations given.

IV.

A further study offers direct evidence that the deflections due to stimuli are caused by electromotive forces. Following are the experimental results:

TABLE XIV.

EXPERIMENTS ON DR. K.

l. h. (+) steady reading.....	— 11.50
Stimulus = pinch, reading rose to..	— 14.0
l. h. (—) steady reading	+ 10.0
Stimulus = burn — rose to	+ 11.5

TABLE XV.

EXPERIMENTS ON DR. S.

l. h. (—) steady reading	+ 9.0
Stimulus = pinch	+ 10.0
l. h. (+) steady reading	+ 11.0
Stimulus = pinch	+ 11.7

TABLE XVI.

EXPERIMENTS ON DR. ST.

l. h. (+) steady reading.....	— 3.5	
Stimulus = electrical shock.....	— 4.5	
l. h. (+) steady reading.....	— 3.0	
Stimulus = burn	— 4.2	
l. h. (+) steady reading.....	— 3.0	
Stimulus = electrical shock.....	— 3.7	
l. h. (—) steady reading.....	— 3.8	
Stimulus = electrical shock.....	— 3.0	
l. h. (—) steady reading.....	— 4.0	
Stimulus = electrical shock.....	— 3.1	
l. h. (—) steady reading.....	— 4.0	
Stimulus (1) = electrical shock	— 3.5	
Stimulus (2) = electrical shock	— 3.0	
l. h. (+) steady reading.....	— 3.2	No change.
Stimulus = multiply $3\frac{1}{2} \times 7\frac{1}{3}$	— 3.2	
l. h. (+) steady reading.....	— 3.2	
Stimulus = (What is the capital of Japan?)	— 3.2	

TABLE XVII.

EXPERIMENTS ON MRS. S.

l. h. (+) steady reading	— 2.5
Stimulus = sudden noise	— 4.0
l. h. (—) steady reading	+ 4.0
Stimulus = prick	+ 6.0

TABLE XVIII.

EXPERIMENTS ON DR. ST.

l. h. (+) steady reading	— 1.3
Stimulus, ice application to arms	— 0.9
application removed	— 1.3
l. h. (+) steady reading	— 1.5
Stimulus (1) hot application	— 1.3
(2) changed to ice application	— 0.9
l. h. (+) steady reading	— 1.8
Stimulus, hot application	— 0.9
l. h. (+) steady reading	— 2.3
Stimulus, hot application	— 2.1
l. h. (—) steady reading	— 0.2
Stimulus, cold application	— 0.3
l. h. (—) steady reading	— 0.5
Stimulus, cold application	— 1.0
l. h. (—) steady reading	— 0.8
Stimulus, hot application	— 1.1

Stimulus repeated gave no further deflections.

An examination of Tables XVI. and XVIII. shows that the effect of the stimulus is sometimes to increase the current and sometimes to decrease the current. This cannot be due to change of resistance of the body, but must be due to an electromotive force.

Table XVIII. shows that both increasing and decreasing the temperature caused the absolute deflections to diminish when the l. h. was (+) and to increase when the l. h. was (—). That is, the change of temperature acted simply as a sensory stimulus causing in every instance an E.M.F. in the same direction relatively to the body, whether the change be an increase or a diminution of temperature. With the l. h. (+) the E.M.F. due to the stimulation was in the opposite direction to E.M.F. already existing in the circuit and consequently diminished the existing deflection, while with the hands reversed (*i. e.*, l. h. (—)) the

E.M.F. due to the stimulation was set up in the same direction as before within the body, which now, since the body has been reversed, is in the same direction as the E.M.F. existing in the circuit. Hence upon reversal the existing deflection was increased.

From all these data it is evident that a stimulus causes a definite deflection superimposed upon the original deflection which is not always in the same direction. Had these superimposed deflections been due to resistance-changes under stimulation then reversing the hands would not have changed the direction of this deflection. But the above data show that in many cases the *direction of the superimposed deflection is reversed with reversal of hands. This effect then having definite direction must be of the nature of an electromotive force.*

Is the electromotive force produced by stimuli, by emotional states and by various other physiological processes due to variations of secretion-currents in the skin?

That the skin has little or nothing to do with the phenomena under investigation can be proven by a series of experiments in which the skin is totally excluded. The skin was covered with shellac and paraffin leaving only the finger nails exposed. Under such conditions definite galvanometric deflections were obtained, deflections induced by emotional states and physiological activities. The following tables obtained with no cell in the circuit are characteristic:

TABLE XIX.

EXPERIMENTS ON DR. ST.

Metal Electrodes — Finger Nails Only.

l. h. (+) steady reading.....	0.0
Stimulus = rising.....	+ 6.0
l. h. (—) steady reading.....	0.0
Stimulus = rising.....	+ 4.0

TABLE XX.

EXPERIMENTS ON DR. K.

Metal Electrodes — Finger Nails Only.

Steady reading	0.0
Stimulus = laughing	+ 6.0
Steady reading	0.0
Stimulus = coughing	+ 1.5

TABLE XXI.

EXPERIMENTS ON DR. S.

Metal Electrodes — Finger Nails Only.

Steady reading	+ 19.0
Stimulus = laughing	+ 50.0
Steady reading	0.0
Stimulus = laughing	+ 4.5
Steady reading	0.0
Stimulus	+ 4.5

Similar experiments were performed with tinfoil over finger nails to improve contact:

METAL ELECTRODES.

Steady reading	+ 13.0
Stimulus = laughing	+ 21.0

NaCl ELECTRODES.

l. h. (+) steady reading	— 30.0
Stimulus = laughing	— 8.0

This experiment was repeated several times with same results.

l. h. (—) steady reading	+ 30.0
Stimulus = laughing	+ 35.0

In these experiments evidently all skin effects were excluded. Deflections under the influence of sensory stimulations were observed which, as in our earlier experiments, show definite directions and which are consequently referable to electromotive forces in the body.

Our experiments thus clearly point to the fact that active physiological, sensory and emotional processes, with the exception of pure ideational ones, initiated in a living organism bring about electromotive forces with consequent galvanometric deflections.

We take great pleasure in thanking Dr. W. Bernis, Dr. A. Stevenson and especially Dr. D. F. Comstock for the valuable assistance they have given us in performing these experiments.

The experimental part of this research was carried out at the Research Laboratory of Physical Chemistry of the Massachusetts Institute of Technology and at Dr. Sidis' psychopathological laboratory.

THE NERVOUS CORRELATE OF ATTENTION. II.

BY PROFESSOR M. MEYER,
University of Missouri.

IV. Automatic Action.

'Automatic action' is not used by all psychologists as meaning the same facts. Some use it as a synonym for instinctive action, indicating by the former term merely that the instinctive action to which they refer is accompanied by little or no consciousness. Others use the word automatic to designate action which is not instinctive, not innate, but the outcome of habit, indicating by the term automatic that it is a kind of habitual activity which is no longer accompanied by much, if any, consciousness. I shall accept the latter definition. The question then is: What is the nervous correlate of automatic action?

Neurological research has made it probable that automatic action resembles instinctive action in this respect that it is independent of the higher nerve centers, that it may continue even after the higher nerve centers have been destroyed. While this resemblance between instinctive and automatic action has hardly been established beyond doubt, let us accept it as a fact. There seems to be, then, a contradiction between this fact and our theory of habit formation. Habits can be formed out of instincts only by uniting the motor part of one reflex arch with the sensory part of another reflex arch through mediation of higher connecting neurons. How, then, can these higher connecting neurons be eliminated without breaking again the newly formed path? It is obviously necessary to develop a special hypothesis for the explanation of automatic action. Neurology tells us that there are always, even at an advanced age, millions of undeveloped nerve cells in our brain, consisting only of a plain cell body, without any fibers and branches. Perhaps we hit the truth in assuming that the purpose of these nerve cells is to make possible the establishment of automatic action.

Suppose a new habit has been formed by reducing, in the manner described, the resistance of the path leading from the sensory point S_p to the motor point M_q. S_p and M_q are supposed to belong to two reflex arches which are very remotely connected, by connecting neurons of a very high order. It follows from our theory that the *formation* of the habit must then be accompanied by much consciousness, since the nervous current from S_p, in order to pass out at M_q, has to take a very indirect, roundabout path, consisting of neurons over which processes from many different sensory points have previously passed, whose corresponding sensations are now reproduced as images. There is also much opportunity for pleasantness-unpleasantness. Fig.

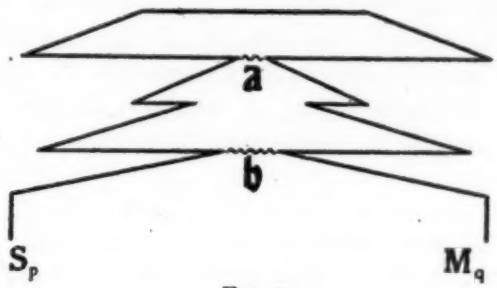


FIG. 2.

2 may be regarded as diagrammatically representing the path of the nervous process at the time when the habit is just established. We notice that at *a* two points of the path are by chance very near each other. Let us assume that in such a case something happens analogous to the electrical tension if the path were a metallic conductor carrying a high-potential electric current. In the latter case a spark would be likely to occur at *a*. Let us make the hypothesis that when a 'tension' of this kind occurs in the nervous system, this stimulates undeveloped nerve cells to send out branches in the direction of this tension. The consequence of this development of a new connecting neuron is a shortening of the path leading from S_p to M_q by putting out of function the part above *a*. This means that the response at M_q occurs with greater quickness and with greater definiteness, since, the shorter the path, the less interference of the current by other currents is likely to occur. It means

further that the nervous process $S_r M_q$ is accompanied by much *less consciousness*, since all those images which depend on a current passing over the neurons above the point *a*, are now excluded.

The same shortening of the path by the development of a new connecting neuron out of an undeveloped nerve cell may occur later at *b*. The total path leading from S_p to M_q is then scarcely longer than a reflex arch. Accordingly the response at M_q to a stimulus at S_p must occur with the same quickness and definiteness as an instinctive response, with little or no accompanying consciousness, and independent of any accidental destruction of those higher nerve centers without which the establishment of this habit would have been impossible. That automatic action is brought about in exactly this manner, we need not assert. Our task was merely to show that the establishment of automatic action, including all the peculiarities mentioned, may be comprehended as a comparatively simple event occurring in the brain.

If the distance between the two points at *b* were less than the distance at *a*, the shortening of the path would immediately have occurred at *b*. This, too, is an interesting conclusion, since we actually notice that habits sometimes pass very quickly from the fully conscious stage into the completely automatic stage, whereas sometimes they become only gradually less and less conscious.

It is plain that the shortening of the path means also that pleasantness and unpleasantness are less likely to occur. Although the path may not be so short that no consciousness at all accompanies the nervous process, yet its shortness makes the process less liable to come into touch with other nervous processes, and without this, as we have seen, pleasantness or unpleasantness is impossible. We understand thus why habituation, familiarity, reduces the possibility of 'feeling.'

V. Vividness and Intensity.

In speaking of attention many psychologists use the term vividness. Let us accept this terminology and call mental states more or less vivid. What then is the nervous correlate of vividness? It is difficult to conceive of its nervous correlate as

anything else than the intensity of the nervous process, the flux. But what is the nervous correlate of the attribute of intensity of a sensation? Must we not conceive of this, too, as the intensity of the nervous process? What distinction is then left between vividness and intensity of a mental state if their nervous correlates are identical?

That there is no fundamental difference between vividness and the attribute of intensity seems to follow from the fact that it is practically impossible to be inattentive to an impression resulting from a very intense stimulus. However, there must be some kind of difference. Our theory can help us to understand this. The intensity of the nervous current, the flux, according to our theory, depends on a number of conditions: (1) On the intensity of the stimulus which calls forth the motor response. (2) On the resistance offered by the path leading from the point of stimulation to the point of motor response. (3) On the presence of other simultaneous nervous processes which may be forced to join the process mentioned first. (4) On the presence of other simultaneous nervous processes which are capable of deflecting the process first mentioned from its course. Our *consciousness* is influenced by all these conditions, and in addition, (5) by the directness or indirectness of the path mentioned under (2), since processes in the very lowest connecting neurons seem to be unaccompanied by consciousness and processes in the highest neurons are accompanied not only by the consciousness corresponding to the point of stimulation but also by consciousness corresponding to the points of stimulation from which previous processes took their way over these same higher neurons, that is, by images. It seems to me that psychologists speak of the *intensity* of a sensation in so far only as the *degree of consciousness* is determined by the — objective — condition stated under (1), of *vividness* when the *degree of consciousness* is determined by any of the five — including the subjective — conditions.

With respect to the first condition it is clear that vivid consciousness must result from an intense stimulus in all senses in which (an exception is mentioned below) stronger physical stimulation causes a stronger nervous flux. This is true, how-

ever, only when in accordance with our fifth condition the nervous process takes a sufficiently indirect path. A process going on exclusively over a reflex arch is unconscious, not attended to, however strong the nervous flux may be. Yet even in case no indirect path has been specially prepared thus far by nervous function of the past, the process can take an indirect path by diffusion if the stimulation is so strong that the simple reflex arch cannot carry the full process. We may say, therefore, that as a rule a strong stimulus brings about vivid consciousness.

Secondly we mentioned the resistance. However strong the stimulation, there cannot be much flux if a great resistance must be overcome; and there may be a considerable flux even if the stimulus is weak, provided there is very little resistance. However, directness and indirectness of the path are as important here as in the former case. There can be no consciousness, however great the flux, if the flux is restricted to the lowest connecting neurons. We perform many reactions with great promptness and force, and yet without foreseeing them, that is, without attention.

Thirdly, the nervous process resulting from a fairly strong stimulus under favorable conditions of resistance is joined by other and weaker nervous processes because of the law of attraction of weaker processes by a stronger one. This can happen only in case the nervous process passes over higher nerve centers, since otherwise it could not meet and attract the weaker processes. Going on in the higher centers it is accompanied by consciousness. Being strong from the start and further strengthened by other nervous processes, it must be accompanied by very vivid consciousness. At the same time we see — according to the theory developed in my previous article — the conditions of pleasantness fulfilled. This explains to us the law, much emphasized by psychologists, of the parallelism of feeling and attention. The conditions favorable to the feeling of pleasantness are also favorable to vividness of the sensational consciousness. I should think, however, that *parallelism*, not causal relation, between feeling and attention is the proper term to be applied to this case. We have no right to say, either that

the pleasantness is the cause of the attention, or that the attention is the cause of the pleasantness, since neither is a regular antecedent of the other.

Our fourth condition is that a nervous process, after becoming established, is deflected by another which is stronger. This means unpleasantness. Here, as in the last case, there is activity in the higher nerve centers, since otherwise there could be no deflection; and the total flux is great because the deflected process joins the deflecting. The accompanying consciousness must be vivid. We see, then, that our statement concerning the parallelism of feeling and attention holds good for unpleasantness as well as for pleasantness.

Thus far we have not found any distinction between the mental correlates of the intensity of nervous flux which would necessitate the use of two terms, intensity and vividness. If there is any justification for distinguishing intensity and vividness of mental states, it can be found only in *accessory experiences*. As above stated, the term 'intensity of the mental state' seems to indicate merely that the subject pronouncing the judgment *knows* that the degree of consciousness (otherwise called vividness) is determined in this case *exclusively* by the objective condition of physical intensity of stimulation. Let us illustrate this by four applications.

(1) In all psychological (especially psychophysical) work concerning the attribute of intensity it is a rule (generally regarded as self-evident) that the subjective conditions must be made, not only constant during the experiment, but also most favorable to the stimulus used; that there must be 'a maximum of voluntary attention.' If we do not succeed in complying with this condition, the experiment is thrown out. This shows that we are concerned here with the degree of consciousness as a function (in a mathematical sense) of an objective condition.

(2) Let us apply our view to the question as to the intensity and vividness of imagery. Imagine a weak sound, and then imagine a strong sound with equal attention, that is, with equal vividness. Has the latter auditory image a greater intensity than the former? Most psychologists will answer: no — there is no difference of intensity; there is no intensity at all. Is this a

strange fact that an imagined sound should have no intensity? I think not. It follows from our theory that the concept of 'intensity of sensation' is not applicable to a case where the intensity of the nervous process, the flux, depends exclusively on subjective conditions, as in our case, where there is no auditory stimulation at all, and where the subjective conditions are identical except for the visual percept of the word strong having been substituted for the visual percept of the word weak. The vividness does not differ, for the percept of the word strong can scarcely have a nervous correlate of greater flux than the percept of the word weak; and of intensity there is none.

(3) Another interesting application is this. How is it possible that the sensation resulting from a very weak stimulus can increase in intensity when attention is given to it? Of course, there are those who deny that this is true. Others, however, assert the fact. In such a case it is well to look for a theory which does justice to both parties, as, I think, our theory does. The nervous process is increased by subjective factors. The mental state shows a corresponding change in the degree of consciousness. There is nothing wrong in saying that the sensation is stronger, as long as we have not adopted any definite language for the description of this experience. On the other hand, no change in the mental state has occurred *in consequence of any change at the sensory point* stimulated. Those who wish to emphasize this fact are quite justified in saying that it was merely a change in vividness. In our *direct* experience, according to our theory, there can be no difference between intensity and vividness. The difference is merely one of *circumstances which may or may not be expressed in our judgment.*

(4) That there are some sensations (*e. g.*, visual) to which the term *intensity* as above defined cannot be applied, is widely recognized by psychologists. But according to our theory such a sensation can possess vividness. Black means the absence of light, but not the absence of stimulation and of a definite nervous process. The nervous process which is the correlate of the sensation black has no less power of deflecting the nervous process which is the correlate of white than the latter has the power of deflecting the former. The nervous correlate of black can-

not be mere nothing, for in that case it could not deflect an actual nervous process. If the nervous correlate of black were not an actual process of variable flux, black could have no vividness — it would be impossible to give attention to blackness. Our refusal to speak of the intensity of a visual sensation expresses merely the fact that the intensity of the physical stimulus in this case does not influence the intensity of the nervous process in the same *direct* manner as the intensity of most other kinds of stimuli does, but through complex physiological agencies in accordance with complicated laws. Nevertheless, the visual nervous process has an intensity of flux, and its mental correlate has vividness.

I can see no objection, then, to regarding vividness and intensity as essentially the same kind of experience, as degree of consciousness. The distinction between vividness and intensity does not mean a distinction between two kinds of mental correlates of nervous flux, but only refers to accessory experiences, to knowledge of the conditions by which the nervous flux is determined in the particular case.

In spite of regarding vividness and intensity as experiences having the same nervous correlate, I doubt if it is advisable to call vividness an *attribute of sensation*, as proposed by Titchener. He calls it the attribute of 'clearness' and regards it as an attribute which, like duration, is common to all sensations except to pleasantness and unpleasantness. These, the 'affective' states, he regards as primitive sensations which, in consequence of arrested development in racial evolution, have not been able to acquire the attribute of clearness. I intend to discuss this matter in another article. It is of fundamental importance in this respect how 'attribute' is defined. My definition[1] differs greatly from that of Titchener[2] — indeed, is quite irreconcilable with his.

VI. Attention as a Faculty.

What does attention, thought of as a power, a faculty of the mind, bring about? It clears up our mental states, Titchener says. It increases the vividness, others say. But all agree

[1] 'On the Attributes of the Sensations,' Psychological Review, 11, 1904.
[2] Titchener, *The Psychology of Feeling and Attention*, p. 8, 1908.

that it does more. It unifies mental states. It forms out of the atom-like sensory material unitary groups made up of smaller groups which possess themselves a secondary unity. What is the nervous correlate of this function?

The fundamental law of nervous function correlating with this function of attention, is according to our theory, the law that *a stronger nervous current attracts a weaker nervous current* if the nervous connections and their resistances make this possible. According to this law two independent conscious processes are impossible. Two independent instinctive or automatic processes may occur, for the nervous processes in these cases pass over lower nerve centers only and thus may be unable to act upon each other. But when we have two conscious processes, the nervous processes take their ways over higher nerve centers and thus must inevitably affect each other. Fig. 3 (identical with Fig. 4 of my previous article) is a diagram

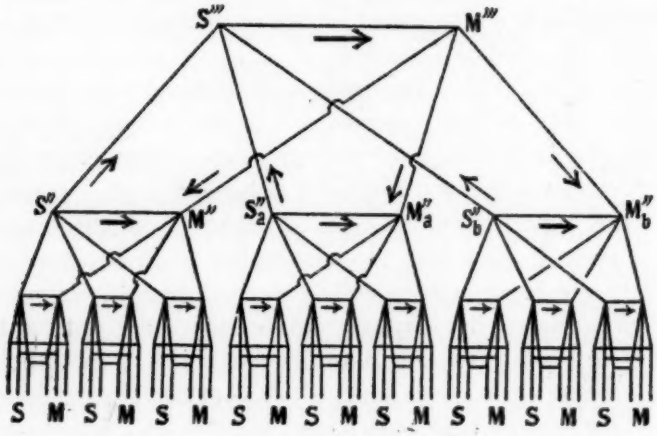


FIG. 3.

illustrating the nervous connections of twenty-seven reflex arches. Suppose the reflex arch belonging to the sensory point farthest to the left and the one belonging to the sensory point farthest to the right are carrying currents. Those currents may go on without in any way interfering with each other. But if the two nervous processes do not take the shortest paths over the reflex arches to reach the motor points, but take the

paths up to S''' and from M''' down to their respective motor points, they must inevitably interfere with each other, for the only condition of non-interference, exact equality of the flux for the whole time of their existence, cannot be fulfilled in an organism except by a miracle. If the one process is — even slightly — stronger than the other, it deflects a part of the other's flux. Thus it becomes capable of forcing further processes started later, to join it rather than the other process. Being strong, it soon reduces the resistance of its path, thus becomes still stronger and deflects yet more of the flux of the rival process. The outcome is that we have only one motor reaction instead of two or more; and only one train of thought made up of related ideas instead of two or more unrelated trains of thought. The *unity of consciousness* is simply the result of the above described fundamental law of nervous activity.

At any moment of time the nervous process may be compared with the current of a river. Just as the river is not, as a rule, the result of the direct union of innumerable small creeks, but of taking in here and there large tributaries, so the unitary nervous process receives its large tributaries. Each of these tributary processes is the nervous correlate of one of several chief subdivisions of the unitary consciousness. Thus we have no difficulty in understanding the actual make-up of our 'field' of consciousness, the 'focalness' of a part, corresponding to the main stream, the lower level of vividness of other mental states corresponding to the tributaries, larger and smaller, down to the lowest degrees of consciousness in the 'fringe,' represented by little streams which have but little flux themselves, although without their existence the great flux of the river would be impossible. The question whether attention has but two or a greater number of levels must be answered from the point of view of our theory by saying that *sometimes it has many levels, sometimes only two.* A river may have practically no large tributaries, but be formed by innumerable small streams emptying into a lake. The mental analogon of this is the consciousness on two levels only. The analogon of a river receiving many large tributaries, which in their turn receive many smaller streams, and so on, is the consciousness on many levels. I do

not believe that the question as to *the exact number of the levels of consciousness* has any scientific significance.

It seems to me that this will also solve a problem which has been discussed by Sidis in recent issues of this REVIEW. Sidis lays much stress on the insufficiency of the theory which distinguishes only two classes of mental states aside from feeling — sensations (perceptions) and images. He points out that there is a great difference between the kinesthetic consciousness of heaviness when suggested, say, by reading the word heavy, and the kinesthetic consciousness of heaviness when I 'see' that a vase standing on the mantelpiece is heavy. Only in the former case will he speak of a kinesthetic image; in the latter he speaks of a secondary sensation. However, we can also charge this theory of Sidis with insufficiency, for there is a great difference between the kinesthetic consciousness of heaviness when I, sitting on a chair, 'see' that the vase on the mantelpiece is heavy, and the kinesthetic consciousness of heaviness when I, having risen from the chair, 'make up my mind' to take this heavy vase in my hands in order to place it on the table. Shall we, then, distinguish primary, secondary, and tertiary sensations? I do not see the value of these distinctions. There are obviously infinitely many degrees of flux of the nervous processes in the connecting neurons of our nervous system and equally many degrees of vividness. Nevertheless, the theory which distinguishes *sensations* and *images* agrees with our observations in ordinary life, where *as a rule* we find either a very high or a very low degree of vividness, stability, and distinctness (detailedness) of our mental states.

The last problem which I shall take up here is this: Why is it impossible to give attention to feeling? Or — as some psychologists would prefer to state it: Why do we destroy, or at least interfere with, our feeling by giving attention to it? This fact appears indeed very strange to one who regards attention as a faculty, a tool, which we apply to our states of consciousness. Why should we be able to apply this tool to all other kinds of consciousness? But if we attempt to apply it to our feelings, they disappear. This kind of thing seems to fit only a fairy tale. According to our theory, however, the fact

is not at all strange. Attention means vividness of a mental state, and the nervous correlate of vividness is the intensity of the nervous flux. But pleasantness and unpleasantness are not the mental correlates of nervous flux, but of changes in the nervous flux if these changes take their origin at points other than sensory points of the body. These changes may be great or small and accordingly we may speak of intense or weak pleasantness and unpleasantness, of intensity of feeling, using the word intensity in its broadest sense, as it is used in ordinary life. But the term 'vividness,' in its special sense, in which we use it in connection with 'attention,' cannot be used here, since it refers to the *quantity of flux*, whereas we are concerned here with the *quantity of change of flux*. That is, we cannot 'give attention' to feeling. This is obviously implied also in the second description quoted above, according to which feeling disappears, when we attempt to give attention to it; but what is meant by attempting — by *willing* — to give attention to feeling?

I accept the theory that the will to give attention is the foreseeing of attention. If we will to give attention to feeling, this may mean that we are vividly conscious of the word idea 'vividness' or a synonym thereof together with the word idea 'feeling,' or 'pleasantness,' or 'unpleasantness.' A vivid consciousness of these *word ideas* has a strong nervous correlate. Now, according to our theory, this nervous correlate must deflect, interfere with, the other nervous process which is the nervous correlate of our consciousness of *the situation*. If the process itself is destroyed, the changes of flux occurring within it are of course destroyed too. That is, we cease to be conscious, either entirely or at least vividly, of the situation; and we also cease to be conscious of its pleasantness or unpleasantness. We see, then, that the fact that we cannot give attention to feeling, that our attempt to do this destroys the feeling, is a simple logical consequence of our theory of the nervous correlates of feeling and attention.

THE WANING OF CONSCIOUSNESS UNDER CHLOROFORM.[1]

BY ELMER E. JONES, PH.D.,
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The phenomenon of the waning of consciousness under an anesthetic is familiar to every physician, yet it is entirely probable that no introspective records have been taken from patients who have submitted themselves to the operating table. The reason for this lack of psychological investigation is to be found in the fact that usually the patient to be operated upon is in no state of mind to give accurate introspective evidence because of suffering, anxiety as to the result of the operation, or intense emotion as a result of some previous experience which renders the operation necessary. Likewise, chloroform to most individuals is so nauseating, and the ordeal of having the drug administered so very unpleasant, that few individuals could be induced to give their attention to the phenomenon of the disappearance of consciousness, and make introspective statements which could be accurately relied upon. Again, physicians themselves do not regard the psychological phases of anesthesia as having any great significance upon the success of the operation, or the recovery of the patient, and consequently no definite experimentation has been carried on.

The field, however, seems rather fruitful. It is probable that it may throw some light upon the stability and deep-seatedness of the various sense impressions, and ideas, and their tenacity under the deteriorating effects of this powerful drug. I am of the opinion also that a thorough experimental study of the waning of consciousness under anesthetics will throw much light on the psychology of death, which obviously enough has never been reported. While not of very much pragmatic value, it nevertheless is of interest, because it is the experience through

[1] Abstract of a paper read at the Washington meeting of the Southern Society for Philosophy, etc., December, 1907.

which all must pass, and probably is the phenomenon which is more universally feared than any other strictly human experience.

The following introspective report is based upon three ministrations of chloroform to the writer, once for the purpose of performing a slight operation, and twice a few months later for introspective purposes alone. In the first event the physicians and attendants knew nothing of the psychological study which their patient was making on himself during the trance. In the latter instances, however, a physician and attendants were employed to administer the drug in the usual way, and to assist in carrying out the tests as previously arranged by the subject. The chloroform was administered rather slowly, in order to give ample opportunity for introspection, and for carrying out the tests previously determined upon. All clothing was removed so that there would be no interference with movements and tactile impressions on various parts of the body. The eyes were uncovered, and every effort made to allow all the sense organs to have full play. The subject being placed on the operating table, the drug was administered in the usual manner as for an operation. It was prearranged to make the following introspections during the waning of consciousness.

First, the disappearance of sense perception, both as to the character of the decrease in acuteness of sense, and the order in which the various senses disappear. In order to study the visual sense the colors of the spectrum were placed on the ceiling directly above the subject, and various objects, such as a book, a few printed words, some digits arranged in the form of a problem in addition, and a few geometrical designs. For the auditory sense it was prearranged that an assistant should read from a book slowly and distinctly, during the entire period of anesthesia, so that the subject might watch carefully the character of the auditory impressions so long as they were felt in consciousness. With reference to touch it was also prearranged that an assistant should touch the body continually in various places with a pointed instrument using as nearly as possible the same pressure. In addition to this test the subject himself, by moving his hands, arms and feet as long as possible, could introspect both touch and the kinesthetic sense.

Second, it was also planned to make introspections upon some of the deeper processes, such as imagery, memory, and reasoning.

At the first inhalation of chloroform there are marked sensations in the vicinity of the heart. The musculature of that organ seems thoroughly stimulated and the contractions become violent and accelerated. The palpitations are as strong as would be experienced at the close of some violent bodily exertion, such as a hundred yard dash, or chinning the horizontal bar very rapidly a few times. The cardiac movements are so accentuated that they are easily felt as pressure sensations on the intercostal muscles, and stretching sensations on the skin immediately over the heart. This violent cardiac reaction is a good example of the efficiency of the sympathetic system in counteracting disintegrating influences in one part of the organism by extraordinary activity in another. Were it not for this stimulating effect of chloroform upon the cardio-musculature the drug could not be used for anesthesia.

Immediately accompanying these cardiac sensations, a peculiar stupefying feeling proceeds throughout the whole body. The blood conveying the drug, as it surges through the body, is felt very clearly throughout its whole course. With each ventricular contraction, as the drugged fluid is forced out into the aorta, it can be clearly sensed in its passage through the various curves and windings of the blood vessels, clear out into the smaller subdivisions, and even into the capillaries. This experience is a decidedly pleasant one, just a little stupefying, and producing in consciousness an effect closely akin to drowsiness, though clearly artificial. One is a little startled at the rapidity of the blood flow, for in a very few seconds every part of the body has been permeated by the chloroform and the anesthetic effects are beginning to be felt.

With reference to the order in which the various types of consciousness disappear under an anesthetic, it should be said at once that there are two sharply defined stages; first, the complete damping down of all the sense organs, so that there is no communication with the outside world whatever; second, the disappearance of memory, all types of imagery, associational processes, reason, and isolated ideas.

In the very earliest stages of anesthesia, probably for the first ten seconds, the visual sense is slightly stimulated. The colors in the spectrum appear a little brighter, letters and figures somewhat clearer, and the light in the operating room, which is always very bright, seems a little more intense. Hearing, for the first few minutes, was almost normal, save a slight roaring, which for a considerable time did not appear to interfere seriously with perfect audition. At this early stage of the experiment various movements were made to test the kinesthetic sensations. For the most part these sensations appeared normal, though the ability to innervate seemed difficult, and to initiate a movement seemed slightly fatiguing. There also appeared in the movements themselves two illusions which were watched with a great deal of interest. First, all movements made appeared to be much longer than they actually were. A slight movement of the tongue appeared to be magnified at least ten times. Clinching the fingers and opening them again produced the feeling of their moving through a space of several feet. Winking gave the peculiar feeling of a great curtain slowly shutting out the light and as slowly rolling back again. Second, all movements seemed much slower than they actually were. Almost from the first this illusion was noticeable, yet the attendants did not detect, in the reactions to the movement stimuli given, any tendency to make the movement slower than under normal conditions. The tactile sense in the early stages of the experiment seemed slightly dulled to the touch of the pointed instrument, yet it could be very distinctly sensed, and accurately localized. At the close of the first two minutes it may be said that there existed a general bodily stupor, accompanied by decidedly pleasant feelings throughout. Senses were slightly damped down and consciousness was agreeably lethargic.

In the three tests made by the writer, the first sense to break down under the influence of chloroform is hearing. While vision is still perfectly clear, and the tactile sense only slightly blunted, audition has begun rapidly to wane. The roaring in the ears, previously mentioned, increases and is accompanied by occasional loud buzzes and thumps. The voice of the assistant who continued reading throughout the test appeared to

lose its articulatory value, and short words could not be heard at all, and all words became considerably fused and blurred. Eventually only an occasional very long word could be identified, and this with great difficulty. Direction of sound was lost very early — about the time when the smaller words were first heard indistinctly. After this the words heard appeared to come from nowhere, and the familiar intonations of the assistant's voice could no longer be recognized. After eight minutes the auditory sense is completely damped down and silence reigns.

It should be said just here that all the deeper conscious states are perfectly normal at this time. Memory is not impaired, the imagination is very active, and a problem in addition was added with as much ease as under normal conditions.

The tactile sense is the second to disappear under the influence of chloroform. As in the muscular sense, so here we find some interesting illusions. At one stage of the experiment when the foot was touched with the pointed instrument, it seemed so far away that the subject wondered if it were possible that his whole body were in a single room. With the disappearance of the tactile sense and hearing the body has completely lost its orientation. It appears to be nowhere, simply floating in space. It is a most ecstatic feeling. Consciousness is now almost pure ideas; it is free from any disturbing stimuli from the sense organs, and is probably just about what is meant traditionally by a free spirit, though it is quite evident that is has decided limitations. My feelings corresponded very closely with Cardinal Newman's description of death in Gerontius's Dream when he says,

> "Down, down, forever I was falling,
> Through the solid framework of created things."

Closely following the disappearance of the tactile sense all muscular control is lost. Muscles are contracted with great difficulty, and innervation is greatly weakened. But it is interesting to note that after all movements have ceased, it is still possible to send the impulse to the proper muscles from the motor centers in the brain. At least there is a distinct feeling of the impulse so moving. This experiment, thus, throws some

light upon the much discussed question of sensations of innervation.[1] If the impulse is clearly felt to pass from the motor centers during partial anesthesia, when it is impossible for the slightest movement to be made in response to it, it seems quite clear that there must be such sensations; for all other factors save the inauguration of the impulse and its passing have been eliminated.

The last movements to disappear are the most highly specialized ones. The figures could be moved for a considerable time after the biceps and triceps refused to contract. The organs of speech could be innervated to movement a considerable time after most other muscles refused to act, but of course speech was defective, and the attendants stated that after seven minutes, words could not be understood because the tongue was unable to make the finely coördinated movements necessary for articulation. However, tongue movements and movements of the eyes were the very last to disappear.

At this stage of the anesthesia the sense element in consciousness has practically been eliminated, but it remains for us to say a few words with reference to vision. This sense yields to the influence of chloroform more slowly than any other. So long as the eyes could be held open voluntarily, vision seemed quite normal, save that the colors of the spectrum faded out into a gray band, and the details of objects could not be seen very well. It was quite clear that the peripheral regions of the retina are the first to be affected, and that as the anesthesia advances the visual field becomes smaller. After all muscular control was lost the eyelids of the subject were opened by an attendant and vision was still quite distinct. All colors of the spectrum were faded out, but light and shadow, and the distinct outline of objects could be discerned. Figures and letters could not well be seen, but larger objects as a book, a watch, a pencil, and a hat were easily recognized. However, at this stage of the anesthesia the whole visual field seemed smoky and gradually faded out into shadows and darkness.

After all sensations were damped down completely there

[1] McDougall, *Physiological Psychology*, p. 87. Woodworth, *Le Mouvement*, p. 45.

still remained an inner consciousness which for the most part was perfectly normal. Memory seemed pretty accurate, and the reasoning powers only slightly deficient. At this stage the subject successfully imaged the faces of several friends, at least two rural scenes, and a piece of music; but failed to image certain familiar movements, such as throwing a ball, lifting a weight, and mounting a horse. An easy theorem in geometry was demonstrated, and each step in the whole process was as clearly seen as if the subject had had a figure before him and could have used his eyes and vocal organs in following out the various processes before him. The memory was tested by repeating a short poem, which was perfectly easy, and by thinking of the names of the presidents in order beginning at Washington. This latter task seemed more difficult, and James Monroe was the last one that could be recalled. At this point there appeared a pretty general disintegration of ideas, and all associations seemed considerably broken. Ideas actually appeared in spatial relations to each other and many miles apart. They were so infinitesimal that they disappeared very readily, leaving an entire blank. These lingering ideas were some of the very first ones gained in life. Memories of boyhood's home, parents, brothers, sisters, playmates almost forgotten, conceptions of a religious nature long since discarded, and a few æsthetic feelings of early childhood. These last ideas, it is true, were so vague and indistinct that they could scarce be recognized, yet the fact that they remained so long as the residual of weakened cerebral activity shows how deep-seated they are in the mental constitution.

TRUTH AND AGREEMENT.[1]

BY PROFESSOR J. E. BOODIN,
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Both realists and idealists have joined in maintaining that truth is *agreement* with reality. But they have failed to state the nature of this agreement. Is truth a duplicate of reality or is it merely symbolic of reality? If the latter, what is the rationale of inventing this symbolism? Dogmatic realism and dogmatic idealism alike fail to break up reality and so fail to show the different meaning of agrement, according as truth is a copying process or is an artificial device. I hope to make these problems a little clearer in this paper.

The problem of correspondence was a simple affair for naïve realism, because naïve realism only dealt with one kind of stuff, one grade of reality. Whether it is a case of like perceiving like, as with Empedocles, or opposites perceiving opposites: cold perceiving hot; the light, the dark; etc., as with Anaxagoras, we still remain within the one nexus of changes; we still have one kind of stuff. This is equally true of the effluences of Empedocles, the *εἴδωλα* of Democritus, and the forms of Aristotle and the Schoolmen, with the passive imprint which these forms are supposed to make upon the the wax tablet of the mind. With a sharp distinction between mind and body, which took definite form with Augustine and was revived by Descartes, the difficulties as to how one set of processes can make a difference to another set of processes, thickened. So we have the terminism of Occam and the phenomenalism of Hume and Kant. There can, on this view, be no correspondence between

[1] Since sending this paper to the publisher, I have read Professor Baldwin's splendid chapter on 'Truth and Falsity,' *Thought and Things*, Vol. II., Ch. XIII. This takes up the same problem from the genetic point of view, and with important agreements in some instances. As I cannot adequately recognize Professor Baldwin's novel treatment without writing a new paper, I offer this as a supplement to the same discussion, dealing with the problem from the more traditional approach.

knowledge and reality, for knowledge moves within a world of its own. It is at most a sign language. We can know nothing about the real world. We know it only as it terminates and is elaborated in our experience. There can, however, be phenomenal verification or anticipation within experience. The world of shadows, also, to use Platonic language, has its uniformities, which make prediction possible. If we are doomed to the world of shadows, we can at least get ready for future shadows.

Idealism, in insisting again upon one kind of stuff, *i. e.*, mind stuff, tries to return to the original simplicity of like acting upon like. So long as the question of the ego is not raised, the problem is easily stated as merely purposive realization or logical connection within one context or unity of thought. When the question is raised, however, as to whose experience or unity, the problem grows more difficult. The idealist must either raise himself into a solipsistic absolute or, in modestly recognizing his own finitude, face the dualism of an internal and external meaning, and struggle over the seeming fragmentariness and darkness of our world.

A new theory of knowledge has been developed in recent times by William James and others, which tries to avoid the idealistic difficulty and presumption by treating knowledge as merely an instrument having no relevancy to the object to be known, but being valid in case it can be exchanged, in the course of the process, for immediate experience, as wares are exchanged for gold. While such a theory, with abundant illustrations from natural science, accounts for how knowledge can control the world of processes, it leaves us in the dark as to the real question — the relevancy of knowledge to its object.

Before we can have purposive selection and correspondence, our selection is determined by our instinctive tendencies. The infant does not have any definite program; it is not as yet a self and so is not concerned about self-realization. It is so constituted, however, as to respond in characteristic ways to certain stimuli, such as moving things, bright things, loud things, things to eat, to grasp, to be afraid of, etc. There is no question of intention here and therefore no question of truth. The infant, as the

result of the evolutionary process, is such a slot as can be set off by just such pennies. What adaptation, fitness or correspondence to its environment there is, *means* fitness or correspondence only to a more developed stage of experience. Its movements do indeed show a certain degree of adaptation, its sense-responses may be said to correspond to stimuli of so many vibrations per second. But they do not mean correspondence to the infant.

Agreement *means* agreement only when we intentionally select in the realization of a certain purpose. Only then does truth or error exist. If I point to Peter when I mean Paul, to white when I mean black, I have failed to carry out my intent and so have erred. To correspond or agree means to realize my purpose or at any rate to be able to act as if my hypothesis were true. Correspondence, however, has a two-fold significance, the instrumental relation of the knowing attitude to its object and that of sharing, to use a Platonic term.

In so far as reflective thought sets its own conditions, irrespective of the inner meaning of the processes, to which it refers, aiming simply at prediction or control of the object as a means to its own purposes — in so far thought is instrumental. Whether the object has any meaning itself or not, such meaning or claim is ignored. And thought must always be instrumental when it deals with that which is immediate and which, therefore, is transformed and done violence to in being dealt with reflectively. This is equally true of brute immediacy and of immediacy on the higher æsthetic level, which presupposes thought life. If reality, therefore, in its ultimate meaning must be conceived as mystical appreciation, which passes knowledge, as the mystics from Plotinus to Bradley have insisted, then knowledge would always have to be instrumental. Again, in bringing our categories — the result of our instinctive equipment and social, historic setting — to bear upon the sense material which furnishes us with our data of nature, with its coexistences and sequences, we can only hope to have instrumental or phenomenal knowledge. We cannot agree that because nature can be made to realize purposes, it is itself purposive, any more than because a knife cuts meat it must itself be meat. It must indeed be

something, *i. e.*, it must be capable of making predictable differences to us. But we cannot treat it as purposive. If there is purpose governing nature, it must be extra-natural, determining survival. The old idea of correspondence, which Kant subjected to such searching criticism, deals with this relation of the concept to the non-reflective or physical world. Here it is easy to show that there can be no real correspondence or copying as we cannot get at, much less reproduce, the inwardness of the processes which we investigate. *We* make the system of nature — unify it, in obedience to our tendencies, on the one hand, and the data of immediate experience on the other — so as to meet the requirements of the environment and, so far as possible, control it for our needs. We are here limited to phenomena.

Sometimes even knowledge of ideal objects is legitimately of this instrumental kind. Treating the circle as made up of infinitesimal straight lines, though convenient, does not correspond even with our ideal reality. The census tables do not correspond to any real order. They are sorted facts for an artificial purpose. Sometimes we ignore the claims of the reflective consciousness, because we regard it as criminal or pernicious to our standards of truth and right. But sometimes we ignore the claims of other meanings because of our moral blindness. The cardinal crime, the crime of crimes, as Kant has shown, is to neglect the inner significance of our fellowman and to treat him merely as a thing. What we respect as having a claim on its own account must differ widely, too, in different stages of development. For the savage, what is outside of the tribe has no meaning which needs to be respected. On the other hand, nature phenomena, ghosts, etc., are treated with more than human respect. In general we find that it is easy to recognize a meaning if it agrees with our own, but difficult the greater the divergence.

Knowledge may be instrumental, then, for two reasons. It may be instrumental because it lies in a different dimension from the object it strives to know. It may be a systematic arrangement, in the service of our purposes, of facts which themselves *know* no system. This must hold wherever science deals with

non-reflective facts, as with the physical sciences. It holds of the psychological sciences, too, when they are not dealing with processes of the reflective or meaningful grade, or when they are decomposing the reflective attitude for purposes of naturalistic description. In so far as our analysis and reconstruction must always fall short of the real object, all our knowledge becomes infected more or less with the instrumental character. We can never, in our description, give the complete equivalents of the real gold or the real Socrates. This can be only when our purpose creates its own object.

But some objects of knowledge at any rate have a meaning of their own, a rational purpose and value, which we must acknowledge. Even here, knowledge, to be sure, must be in some degree instrumental, as we have seen; but this is only incidental, a stage in the process of sharing or sympathizing with the object. The problem here is no longer one of mere manipulation. The correspondence here cannot be exhausted in the one-sided relation of hypothesis to immediacy within the process of individual experience. The judging attitude here is a different one from that of means and end. The fulfilment of our purpose here is conditioned upon partaking of an extra-individual realm of meanings, respecting and sympathizing with them. We do not want to make over or control Shakespeare's Hamlet or the Sistine Madonna or the friend that we love. We want to understand and appreciate them. Our knowledge, when it is concerned with social or ideal structures, is primarily of this sharing character. It is not the business of the historian to make over the past; but to understand it or share its meaning. Even when our aim is that of the practical reformer or when we must revise the scientific hypothesis, it is first incumbent upon us to understand or share the ideals which we would revise or reinterpret. To fail to recognize in the universe any purpose but our own, is to be a bore or a criminal. Some individuals must be respected as having a meaning of their own and cannot be treated merely as things, if we would live fairly and, in the end, accomplish our purposes. To be sure, our limitations as finite beings and as part of the time-process makes such sharing difficult; but it remains, nevertheless, a real aim. Plato has a word for us, as well as the modern instrumentalist.

In instrumental knowledge, as we have seen, the question is merely how the facts *seem* to us; how they can be controlled by us; whether our concepts terminate in perceptions. Not so in the knowledge of the sharing type. Here the truth attitude is not merely an artificial tool, like an astronomical ellipse or a census table; but of a piece with the real object which we strive to know and accommodate ourselves to. The knowing attitude and the object are of the *same kind* or belong to the same grade of reality. In so far as the knowing attitude here can be completely realized, it is no longer *of* reality; but it *is* reality. To know the meaning of Hamlet is to have the reality of Hamlet. Leibnitz's monads are a splendid illustration of a universe which might exist in many copies.

To be sure, here, too, the concept or hypothesis must terminate in immediate experiences, present or future, within our individual history. But these become signs, real energies though they are in their own grade, of another reality which we strive to reach. We do not stop with the spoken or printed words. These become symbolic merely of the meaning. The difference in the two attitudes may be said to be a metaphysical difference, *i. e.*, a difference as regards the ultimate intent of the knowing process, rather than methodological. The finite test of the correspondence in either case, the test available from moment to moment in individual life — whether in knowledge of the instrumental or sharing type, is an internal test or the corresponding of our purpose or hypothesis with the ongoing of experience. It means an attitude of fulfilment or forced acknowledgment in this ongoing.

The knowing process, however, is *really* valid, only when it reproduces or copies the object, *is* the nature of the object. The only valid hypothesis about a reflective object is the attitude that acknowledges the meaning of the object and succeeds in sharing it — aims beyond sense-experience at its metaphysical reality. Whether this aim or intent is true or not must be tested, as in the instrumental case, with reference to further experience. But this attitude, if true, *terminates in sharing* and not in mere perceptions and their uniformities.

Another center of experience is acknowledged, which has

put its prior stamp upon our self-stamped facts. The attitudes in the cases of sharable and non-sharable realities are built out in different ways; the former has over-beliefs that the latter does not have, and so requires a different verification — a verification including the over-beliefs. When such sharing is impossible, we must be satisfied with such artificial or phenomenal correspondence as the uniformity of our perceptions makes possible.

By copying I do not mean a mere photographic copy, as is sometimes meant. I cannot see what meaning such copying has in the process of knowledge. To suppose, for example, that our sensations are copies of independent characters of the object, assumes a duplication of our sensations to which I cannot subscribe. The sensations are not copies; they are definite energetic relations of our psycho-physical organism to the objective world. Neither are our images as such copies. They are relatively persistent processes of experience, modified by intervening rearrangement. They become representative when, at least functionally, they are the same in more than one context, and therefore when excited in the context of present experience can suggest another context with its dynamic coefficient and time value. When it comes to meanings, the question of copying, even as regards our perceptual meanings, can only arise when we have in mind the sharing of such meanings by several subjects. What the copy theory of sensations implicitly assumes is a social consciousness, finite or absolute, in which the sensory qualities exist as such, and therefore the individual must regard them as prior to his experience. But that simply amounts to that they are not arbitrary, but arise under definite conditions.

I agree with the realistic insistence upon the transsubjective reference of the momentary meaning. But the paradox, often pointed out by the realists, that the object must be both in and out of experience, must remain an absolute mystery so long as we deal with meanings as subjective pictures, enclosed within the magic circle of an epiphenomenal consciousness. This paradox is ignored, not solved, by having recourse to mystical or esthetic theories as regards the continuity of the meaning with reality. If we, however, regard the universe under the concep-

tion of plural energetic centers, with various ways of connecting up, and some at least capable of inner content and meaning; and if we regard purposes as themselves energies, evolving in complexity in conjunction with, and having survival value through their control of, other energies such as the physiological, then the paradox is resolved, even though the practical limitations remain. We have at least found a motive for our ideas seeking agreement with their intended reality, for successful adjustment depends upon such agreement.

The object at any rate is more than the intent. If the drama of reality consists only in a series of subjective doubts, readjustments and satisfactions, then Protagoras is indeed right, if we may trust Plato's quotation, that "to whom a thing seems that which seems is." But in that case, what need could there be of readjustment within the stream of meanings? Why does not the meaning at any one time exhaust 'the situation'? Why should there be failure or the necessity for accommodation to a larger world? Evidently the meaning does not exhaust the reality of the object.

This inadequacy of the internal meaning to constitute its own object can be shown equally well on the level of sharing as on that of instrumental knowledge. Is Ibsen's meaning made or created in each stage of the process of the reader's interpretation? Is not the object here something preëxisting and external — not made by the critic? And must not the critic's meaning conform to this in order to be valid of Ibsen's meaning? By ideal construction we try to reproduce for ourselves the meaning of Ibsen's play. We gather data accordingly; but the truth we have first when our meaning imitates the other meaning, when it gives an adequate copy of the other meaning. In such a case the idealists are quite right that the agreement must be with truth, an objective constitution of truth, and not merely with immediate experience. I cannot, however, see what agreement with truth can mean unless you assume that the object itself is a truth process. If the universe as a whole is truth, a system of experience, then of course all truth ought to be a copy process. But I do not think this has been proven. Stringing nature on our reflective unity does not make nature a reflective unity. There is, in so far as we know, no truth or system in nature. Nature

only furnishes certain changes, interactions and constancies which we can seize upon and systematize to suit our needs.

In the case of the knowledge of other egos, we easily recognize that there must be not only internal fluency, there must be also an intent, a creative imagination, taking us beyond the stream of subjective processes. Other egos must be *ejects*, not mere percepts. Hence no theory of mere fluency or coterminousness is sufficient. There must be this but more. And if the other egos respond *as if* our intent were true, then we share their meaning. In regard to nature, too, what we *intend* is not merely immediate experience, whether sensory or affective. Sensations are not the object of sensations. Satisfaction does not give satisfaction. By the uniformity of nature we do not mean mere sequence within experience, but a regularity in nature which accounts for the uniformity of our perceptions and to which we must accommodate ourselves. While in the case of nature, the inwardness must remain problematic, here too, as well as in the case of our fellow-men, the ego means more than the stream of individual experience. It means to meet and adjust itself to a world beyond that experience, even though capable of being energetically continuous with it. This objective reality, in however phenomenal a way, must ratify our intent.

The immediatists themselves have fretted a great deal lately at their misinterpretation by others. But why should they fret? Their critics, realists and idealists alike, seem to be satisfied with their interpretation; and that is all the immediatists ought to ask. If they say that the critics ought not to be satisfied, they have evidently insisted upon a reality beyond immediacy and something beside subjective satisfaction as the test of truth — upon correspondence with an objective reality.

We never shall have a true theory of knowledge until we recognize the complexity of reality in its various stages. We have seen that those who have made the knowing attitude exclusively instrumental have borrowed their illustrations altogether from the physical part of reality. They talk about knives and chairs and chemical formulæ. They are apt to ignore another part of the environment, which to a human being is at least equally important with the physical, viz., the institutional. Could the object be treated altogether without any reference to

any purpose or meaning of its own, then the instrumental theory would indeed cover the field. Were reality through and through reflective or conceptual, on the other hand; must we acknowledge it as one system of meanings, then Plato and all his disciples would be right, that all knowledge in the end must be expressed in terms of sharing or imitation,—a copy of the inner meaning of the processes at which it aims. In so far as it should succeed in this, the distinction between truth and reality would disappear; the idea would *thicken* into being. As it is, it is both sanity and fair play to treat reality as its nature demands, instrumentally, where no purpose need be acknowledged; sympathetically where the conditions so demand.

Whether a man shall be an idealist or a materialist is not a matter of consistency, but of claims which we must meet. Where we must recognize ideals, as in dealing with the institutional life of the race, we must be idealists. Where our ideals have no inner relevancy to the processes with which we deal and the aim is merely control, we must be materialists. Here a one-sided *a priori* consistency is as mischievous as in other departments of life. To institutionalize nature by giving it reflective life and ideals of its own is to leave evidence for fairy tales. To ignore purposes and meanings, where we ought to understand and meet them, is to show one's lack of imagination and unfitness for social life. Thus the truth of Plato, as well as of Kant and James, is recognized. The one-sidedness of the instrumental theory consists in ignoring that part of the evironment which is institutional; is itself meanings or ideals. The one-sidedness of Plato and his followers is that they attempt to institutionalize nature as well as man.

But the instrumental theory does not satisfy the claims of the successive moments of individual life any more than it does the social claims. It is not fair to regard each moment of appreciation or reflection as a mere instrument to another moment. If each moment has no significance or worth of its own, is a mere instrument for meeting a future moment, then life as a succession of moments can have no significance. Instrumentalism, bare and simple, must lead to brankruptcy. Each moment must be respected as end, as well as means. Every genuine moment is a thing of beauty and of joy forever, as well as the

parent of a new moment. And again, every false and perverse moment is a tragedy never remedied, as well as a call for reconstruction, if there is such a call, or an obstruction to further living. The universe, in other words, is not merely fluid. If it were, it would be nothing. Each moment and each stage of life is an individual reality with its own warm and living meaning, which to lose is to lose all.

The knowledge of purpose by purpose I have called real knowledge. It is so to a degree at least, *i. e.*, just so far as the purpose, whether institutional or individual, is grasped. Real knowledge is knowledge of the thing-in-itself; and human purposive wills are among such things. Knowledge of the merely instrumental kind we may, out of regard for Kant, call phenomenal knowledge. If we say that these attitudes, *i. e.*, the instrumental and sharing attitudes, are different hypotheses in regard to our world of objects, we must not forget that these hypotheses, owing to a long survival process, are instinctive or intuitive so far as the individual is concerned, long before they become conscious hypotheses or postulates.

The confusion in recent discussions has come in part at least from the failure to distinguish between truth and reality.[1] Truth is our version of reality. The geological ages existed as characters or processes of reality long before we discovered them, but the truth about them did not exist before we discovered them. It is nonsense to speak of an hypothesis, which is our meaning or attitude, as true previous to verification; but previous to verification there exist certain conditions, which make some hypotheses come true. These conditions, in most cases, are not altered by our hypothesis. The chemical properties of gold are not altered by our faith; the condition of our nerves may be. The 'laws' of nature are contributed by the man who discovers them; and science very properly, therefore, deals with the laws biographically, as Newton's law, Carnot's law, etc., though once discovered they become social and eternal.

[1] It is very evident that we need to use terms in a technical sense in order to prevent the discussion of truth from being more than a play on words. I believe, however, that we would only increase the confusion by adopting the distinction between truth and truthfulness suggested by James in the *Journal of Philosophy*, etc., for March 26, 1908. The term truth has a definite meaning, and it is hardly possible or desirable to change it.

Nature furnishes existences, uniformities of various sorts, but no laws, no truth. These laws or expectancies become true when nature behaves in the predicted way. This is all that correspondence in regard to nature means. It is not a one to one correspondence, as we only hit at best a few places of reality; and only a few are significant for us. Truth, looked at from the individual point of view, becomes agreement with truth, when we imitate or make our own truths already existing, hypotheses already verified, social truths. Here we do copy truth, within the limitations of human nature. Truth need not mean, and cannot except to a small extent mean, individual verification. An hypothesis or law is true, if some one has really verified it. Going over it again in such a case does not make it true. It simply relieves our nervousness and confirms our belief. But our belief or doubt neither verifies nor undoes the verification of an hypothesis, though it may furnish a motive for testing it.

As I see it, both the anti-pragmatists and the pragmatists have contributed to the confusion — the anti-pragmatists by tacitly, often unintentionally, assuming an absolute system of truth with which we must agree; the pragmatists by their intense individualism in practically insisting that truth is not truth, unless it has passed through their particular cranium. Of course a truth is not *my* truth unless I make it my own by going over its grounds, tracing it to its termination in the intended facts. But going over an hypothesis already verified does not make it true or valid. This is a social fact. Whether I make it my own or not is tremendously significant for me, but not, unless I improve upon the hypothesis, a contribution to truth. Whoever the legatee or individual producer of truth may be, it is quite sufficient that truth exist in one individual consciousness, as his systematic meaning, whatever the other individuals may mean. If everybody should sleep the sleep of Endymion, there would be no truth. If, on the other hand, there is an omniscient, ever wakeful God, his possession of the truth would give it all the *validity*, that its possession by billions could possibly give it. The question in any case would be, Does it terminate in facts? Does it, as judged by either past or present or future experience, or all of them, meet the reality we intend or which is forced upon us?